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THE NEED FOR RESEARCH IN ANIMAL NUTRITION IN THE TROPICS.

It is more than a century since Thaer attempted to apply quantitative control in the nutrition of livestock by comparing the feeding values of various substances with that of hay. His "hay-equivalents" may seem crude in the light of present-day knowledge, but his work stimulated researches which have made possible the modern marvels of animal husbandry—"baby beef" animals weighing 7-8 cwts. in twelve months, dairy cows yielding 2,000 gallons of milk in a lactation, and hens laying 300 eggs per year. A summary of the various factors to be considered in formulating a ration shows the complexity of the subject. Proteins and carbohydrates must be supplied in quantitative and qualitative adequacy in order to build up the tissues: calcium and phosphorus should be present to form the bony skeleton: sodium and potassium to maintain the physical properties of the blood and other body fluids: and chlorine to aid digestion of the food. Other mineral elements are also necessary, such as iodine for the thyroid secretion; iron, copper, and possibly also manganese for the red blood pigment; and sulphur, zinc, and even flourine for purposes which have not yet been fully explained. The numerous vitamins must not be forgotten, although the practice of feeding greens whenever possible mitigates the chances of an absolute deficiency.

Generally speaking, most of these factors are considered in Britain, where grazing lands are limited and the margin of profit is narrow, but in the tropics there has always been a tendency to allow the animals to feed themselves. It is generally recognised now that uncontrolled range feeding is unsatisfactory in most cases, as much of the animals' food is wasted in supplying the extra energy required for grazing. Moreover, they eat the more nutritious grasses and allow the more rank and unpalatable plants to flourish and finally predominate. Further, this type of stock-feeding is most commonly applied to beef animals for export, and therefore a relatively large amount of calcium and phosphorus is exported every year in the form of bones. Unless this loss is replaced in some way the pasture will

ultimately become deficient in one or both minerals. Stall-feeding, on the other hand, is widely practised with working animals, and in this case a well-balanced ration will result in a greater output of work per animal, as well as a longer useful life. But the greatest care of all is necessary with dairy cattle, since any nutritional deficiency is immediately reflected in the yield and quality of the milk.

The greater part of the humid tropics was originally covered with forest, and early settlers found it most profitable to exploit the land by growing crops. Tea, sugar, coffee, cocoa, rubber and coconuts have each in their day given substantial profits, and the lack of good fresh meat and milk was accepted as an unavoidable drawback to life on the plantations. In recent years economic affairs have undergone great changes, so that the planter has to face heavy losses, and there is a tendency to regard the colonies as a place of more settled residence instead of temporary exile. Consequently, conditions of life must be made to approach in standard those of temperate climates, and the supply of fresh food should be maintained as an internal industry. The difficulties are many. If an area of tropical rain forest is felled, grass will appear almost immediately, but the natural sequence is for the vegetation to revert to "secondary bush". Frequent cutting of this woody vegetation will eventually result in more or less permanent grass, but this will be of low feeding value in most cases, so that a relatively large area per animal is necessary. In parts of the tropics such conditions are found naturally, where frequent fires have prevented the growth of trees, and in these areas the attempts to rear stock have sometimes resulted in general under-nutrition, while in other places the lack of one or more minerals has produced malnutrition of various types. In short, extensive exploitation of the natural grasslands of tropical countries is almost certain to be difficult, since the very presence of grass may indicate that the ecological conditions have been unsuitable for highly nutritious plants.

Chemical analysis of the pasture would show the deficiencies, and where lack of minerals is the main factor, the feeding of a mineral mixture would allow stock-rearing to be carried on profitably. Where the growth of grass as regards protein, starch, and fat is poor, the application of nitrogenous fertilizers would, in many cases, greatly increase the yield and palatability. The intensive system of rotational grazing has aroused much interest in Europe, and in its general principle this would solve many problems in the tropics, although it is likely that much modification would be necessary; in many places new grasses would have to be introduced, as the natural grasses are not suitable for developing into "cultivated pastures". Both in Jamaica and in Queensland the introduction of new grasses suitable for the climate and soil, combined with controlled grazing in paddocks, have greatly improved the beef industry. Another method is to grow the fodder grass as a cultivated crop and to feed the animals in stalls, but this applies more to work oxen and dairy cattle than to beef animals. This raises the question of the effect of frequent cutting of fodder grasses, such as Elephant Grass and Guatemala Grass, and it is doubtful if the results of Woodman's work with British cultivated pastures can be applied to the various grasses of the tropics. Experiments have been laid down at this College to find the optimum frequency of cutting, as there seems to be little or no information on this subject.

Whatever method is used, a great deal of preliminary experimental work is necessary. Little is known of the food requirements of tropical cattle, and without this fundamental knowledge attempts to improve the industry would be uneconomic in many cases. For instance, Warth found definite differences between Indian and American cattle as regards digestive capacity: at Bangalore the starch equivalent of 100 lb. of rice straw was found to be 40, while the figure obtained in America was 25, no difference in chemical analysis being evident. He concluded that: "both the nature of the food and the breed of the animal influence the amount consumed and the amount digested. The nature of the food exerts a greatly preponderating effect, and hence the main work on animal nutrition must be concerned with foodstuffs, but the fact that the breed may also exert a perceptible effect deserves attention, for it is just this perceptible effect which may make a breed more suitable or less suitable under particular circumstances."

From this brief summary, it is evident that stock-feeding in the tropics is based mainly on trial and error. Where rations have been calculated, the food values have usually been worked out under sub-tropical or temperate conditions, and, as Warth points out, this analogous reasoning is not justified by experimental evidence. Knowledge is required on the effect of breed on digestive capacity, since the grading-up of Zebu with pure-bred European cattle may have far-reaching effects on the metabolism, apart from the fact that air-temperatures approaching blood-heat may influence the life-processes generally. Mineral metabolism probably plays its part in resistance to disease, as the recent work of Orr and his colleagues suggests, and here also our information as regards the tropics is confined to empirical observations. The whole subject bristles with problems which are of the utmost importance from both the economic and scientific points of view.

MALADIES AFFECTING ARROWROOT IN ST. VINCENT.

By A. K. Briant, M.A., Dip. Agric. (Cantab.), A.I.C.T.A.

Done

I—"Burning" Disease of Arrowroot.

(Caused by *Rosellinia bunodes* (?).)

The "burning" disease of arrowroot has been recognised in St. Vincent for a great number of years, and has already been described by Nowell (1). Certain historical facts and observations recorded, may, however, be repeated here as they lend valuable support to the writer's arguments and conclusions. The disease was probably first recorded in St. Vincent in 1891, when affected rhizomes ("roots") were sent to Kew and thence to Dr. Marshall Ward, who reported that they were infected with a fungus which produced a conidial stage resembling that of *Spicaria*. He was, however, unable to make an exact determination of the organism (2).

In 1911 South visited the island and after studying the disease in the field, recorded his observations in an unpublished report (3). He observed that the fungus attacked a considerable variety of host plants other than arrowroot, and that the symptoms of the disease were somewhat comparable with those of root disease of cacao. He did not discover any fructifications by which the fungus could be identified. Two of the most important observations which South made were that :—

(1) the disease occurred year after year in certain patches of soil,
(2) the extension of these diseased patches was very slow.

The importance of these observations was not realised at that time, and will be discussed later. The persistence of the fungus in the infected patches was well illustrated by a certain field which, being severely affected with the disease, was thrown out of cultivation and allowed to remain in bush fallow for twenty-five years. At the end of that time, arrowroot was again planted. When the first crop was harvested a number of rhizomes in certain patches of the field were found to be affected while the second crop was again badly diseased.

In 1915, Nowell (4) after having observed the symptoms in the field and the conidial stage of the fungus actually growing from diseased rhizomes in a heap, concluded that the fungus concerned was *Rosellinia bunodes*. He, like South, noticed that the disease occurred in the field in fairly constant patches, which increased in size only very slowly. Furthermore he attempted to explain the existence of these persistent patches in the field by stating that :

(i) arrowroot is planted in the same field year after year and the ground is never clear of plants,

(ii) it is impracticable to remove the smaller fragments and offshoots of the rhizomes from the ground,

(iii) it is customary when digging the rhizomes to break off pieces and return them to the soil as plant material,

(iv) diseased rhizomes are usually left to decay on the spot.

One of the main objects of the present writer was to visit as many arrowroot estates as possible, with a view to obtaining information regarding the incidence of "burning" disease, and to observe the actual conditions under which it occurred.

Diseased fields were actually examined at :—

Mesopotamia Valley (including Carriere Estate), Lauder's Estate, Three Rivers Estate, and Sans Souci Estate (one small patch only).

There was apparently no "burning" on the following estates :—

Diamond, Carapan, Spring, Union, Pembroke, Cane Grove, Rutland Vale, Peter's Hope and Wallilabo.

At Carriere Estate in the Mesopotamia Valley, one of the infected fields was situated on the side of a very steep hill. The disease occurred chiefly where the contour lines of the field were concave (in the "valleys"), in definite patches which were elongated in the direction of the greatest slope. Running along the side of the hill almost at its foot was a canal which for several months of the year conveyed water to the mill. Below the canal there was another field which was inclined to slope in the same direction as the hill, but was rather irregular and contained a number of depressions (Fig. 1). It is known that arrowroot cultivation on this field was temporarily abandoned because of "burning" disease about thirty years ago. Since that time arrowroot has probably been planted on other occasions, and the field was planted with it again in 1931. Last year the crop was quite badly affected, the weight of bad "roots" to good being about 1 : 8. The real loss, however, was greater than these figures indicate, because affected plants are frequently killed before their "root" development has been completed. In 1932 arrowroot was planted again, and owing to poor germination (probably due to *Rosellinia*) was replanted in May. When the resulting crop was visited by the writer, "burning" was found to be very severe, especially in the low lying areas or depressions already mentioned, but the disease was not

confined to these areas. The field appeared to be more badly diseased than any other field examined. In order to examine the subsoil beneath one of the affected low lying areas, a hole three feet deep was made. Even at this depth, nothing but friable dark soil was to be seen, indistinguishable in appearance from the surface soil. When the surface of the soil was exposed by removing the light covering of dead arrowroot leaves, it was seen to be mottled with abundant conidial fructifications of *Rosellinia* (Fig. 2).

At Lauder's Estate "burning" disease was seen to occur in small patches only a few feet in diameter near the top of a cultivated hill. On the site of one of these diseased patches a hole was dug about three feet in depth, and it was found that a subsoil of wet coarse sand occurred about twenty inches below the surface. A few yards away from this hole, a similar hole was made on a healthy site. In this instance there was a gradual transition from the soil at the top to "tarris" ("terras") below, with no sign of anything in the nature of sand. A third hole dug in another infected region showed that the soil and subsoil were both inclined to be of a sandy nature. Within a distance of thirty yards there occurred three different combinations of soil and subsoil.

On Three Rivers Estate diseased patches which were slightly elongated in the direction of the slope, were again observed on hill land (Fig. 3). In this field, variations in the amount of soil moisture were indicated by the appearance of the undisturbed surface of the soil. At a depth of three inches the soil in the neighbourhood of healthy plants was considerably drier than that in the infected patches.

On Sans Souci Estate "burning" disease occurred in a field more or less at the base of a hill, and close to the edge of a ravine about fifteen feet in depth (Fig. 4).

Discussion.

It was soon realised that the disease was chiefly confined to hilly inland districts where, as might be expected from the nature of the country, the rainfall was fairly heavy. The drier coastal lands were, on the other hand, not usually affected. A definite relation between rainfall and the incidence of the disease would be difficult to obtain because of the limited number of rain-gauges in the island. The actual rainfall in some of the infected districts is probably somewhere in the neighbourhood of 120 inches per annum. Rainfall, however, is only one of the factors which help to produce the conditions necessary for the fungus to be destructive, as is indicated by the presence of the infected patches in the field.

Although Nowell suggests reasons for the existence of infected patches, neither he nor South attempt to explain why the patches are so definite and persistent, nor why their extension is so slow. This latter point is interesting because there is evidence that the growth of the fungus within the infected areas is very rapid. In the writer's opinion the incidence of "burning" disease is dependent on certain soil conditions, and the infected areas represent local patches of soil in which those conditions are present. It is further believed that the chief factor concerned in producing the conditions is the amount of soil moisture. This does not imply that the soil in the diseased areas is waterlogged, for not only would it be difficult to imagine St. Vincent fields to be in such a condition, but also, *Rosellinia* itself would not thrive under these circumstances. What is implied is that the soil is continually in a damp condition produced by a fairly regular flow of water either from above or below.

That moisture plays some rôle in determining the parasitism of the fungus is suggested by the fact that the disease is practically confined to wet inland districts. It is frequently assumed that soil on a cultivated hill side is naturally well drained. Such an assumption however is unjustifiable. The observation of cuttings by the roadsides where the various strata have been exposed (*e.g.*, in the Mesopotamia valley), revealed that embedded between two apparently dry layers of "tarris", there frequently occurred a stratum of coarse sand, from which water was often seen to trickle. The fact that water accumulates in and is retained by the layer of sand indicates that the permeability of the "tarris" to water is not very great. Similar seams of sand undoubtedly exist as part of the strata underlying cultivated hillsides and the percolation of water from such seams into the soil would readily account for wet patches in the field (*c.f.* observations at Lauder's Estate). The subsoil of most fields is composed of "tarris" which certainly is not as porous as the soil above it. Moreover it is possible that a subsoil pan may sometimes occur. Whether this pan is produced or not, it is more than probable that in sloping fields water tends to seep down the slope in the soil itself rather than penetrate the less permeable subsoil. The result of this downward trend of the water would be to produce patches of wet soil which are elongated in the direction of the slope. Further down the slope the high water content of the soil may be reduced by evaporation and better subsoil drainage conditions.

These phenomena may be illustrated by a diagram (see overleaf).

In the opinion of the writer, wet patches of soil produced in this way are responsible for the occurrence of elongated patches of "burning"

MALADIES AFFECTING ARROWROOT IN ST. VINCENT.

Fig. 1.

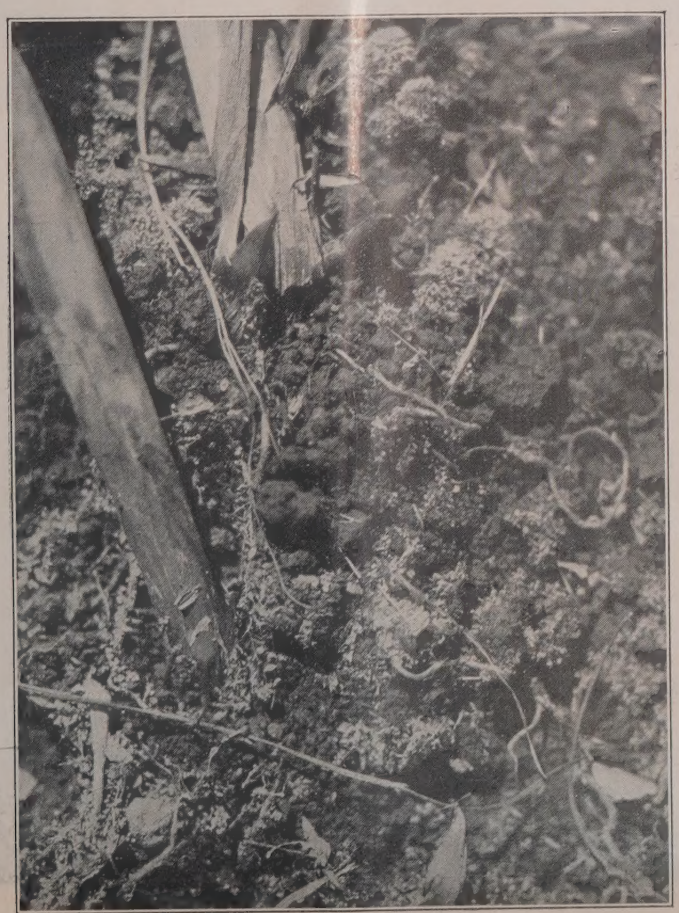


Fig. 2.

MALADIES AFFECTING ARROWROOT IN ST. VINCENT.

Fig. 3.

Fig. 4.

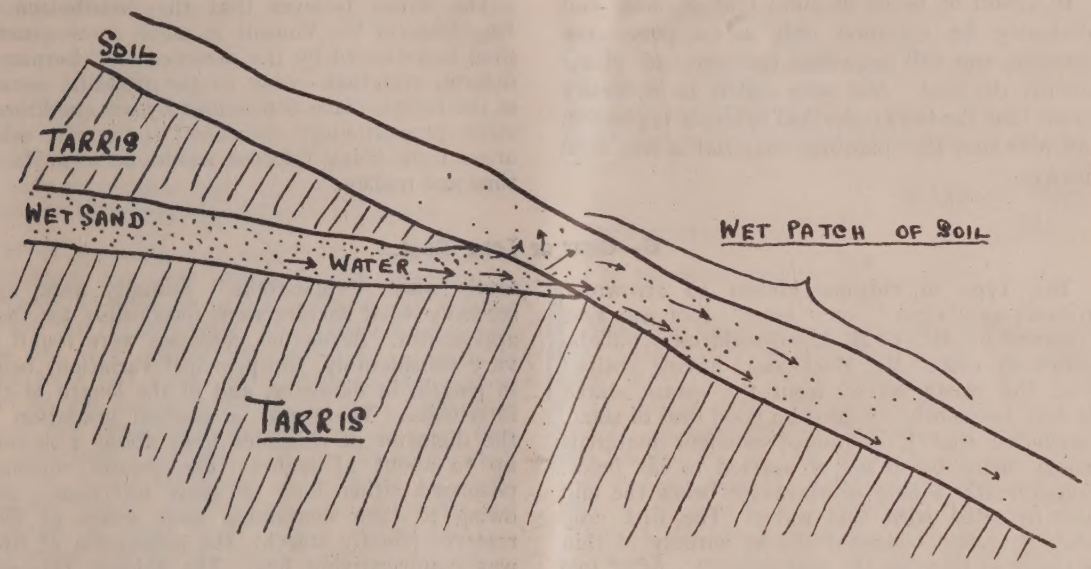
FIG. 1.— *An alluvial area supporting an excellent stand of the Giant Fig variety. In the background (right) the lower slopes of the hillsides have been cleared for banana cultivation.*

FIG. 2.— *A good example of a broad valley supporting extensive stands of bananas. The extent of hillside cultivation is also shown.*

CULTIVATION AND DISEASES OF THE BANANA IN BRAZIL.

FIG. 3.—*A well developed plant of the Cavendish variety prior to the emergence of the bunch, growing on "tabatinga" soil. (Labourer's height approximately 5 ft. 8 ins.).*

FIG. 4.—*A broad alluvial valley entirely devoted to banana cultivation in the State of Sao Paulo.*



disease such as were observed on Carriere and Three Rivers Estates. On the latter estate the higher water content of infected patches of soil was particularly obvious. Moreover, the diseased areas in the upper field at Carriere Estate occurred chiefly in the "valleys", the position in which water, if any existed, would be most likely to seep. The cause of the severe infection in the lower field on this estate is also attributed to seepage. In addition to possible percolation of water into the soil from the subsoil, there was probably considerable seepage from the canal which formed the upper boundary of the field. It was evident from the presence of the conidial stage of the fungus in such abundance on the surface of the soil that the latter was in a very damp condition.

The only other estate on which "burning" disease was actually observed was Sans Souci, the climate of which is probably considerably drier than that of Carriere, Three Rivers or Lauder's. The fact that on the whole estate only one small area was affected is significant, as it indicates that the soil conditions in this area are somewhat peculiar and unusual as far as this particular estate is concerned. Although the position of the infected area in relation to the ravine might suggest that good drainage conditions exist, it is believed that the cause of the disease may also, in this case be justly attributed to the same primary factor, namely, excessive soil moisture. The presence of a seepage of water into the soil and a relatively impermeable subsoil would mean that the water chiefly moves in a horizontal direction. Subsequently most of the water might eventually be removed from the soil by the ravine, but only after the damage has already been done.

With regard to *Rosellinia* diseases in general, the writer entirely agrees with Dr. Briton-Jones that the presence of *Rosellinia* in a field does not necessarily mean that it will become parasitic, even if a suitable host is present. The fungus should be regarded as a common saprophytic inhabitant of soils, especially of those rich in organic matter, its pathogenic capacity depending entirely on the presence of certain soil conditions. If this were not the case the "burning" disease of arrowroot would certainly be more prevalent than it is, and would be distributed more generally in the field instead of being more or less confined to certain localised patches.

Control.

It is believed that "burning" disease of arrowroot in St. Vincent could be successfully controlled by draining the affected fields. On sloping land, especially if the slope is steep, this operation should be carried out by digging contour drains, so that the drains are almost at right angles to the direction in which the water would tend to seep. This would not only mean that the path of the water is more likely to be interrupted by the drains, but also that in the case of heavy rains, the flow of the water down the drains would be slower, and less washing would take place than would be the case if the drains ran at a steeper angle. It is important that drains should be inserted near the source of the seepage, so that the water is removed as quickly and directly as possible, and its passage through the soil prevented.

The depth and spacing of the drains required would vary according to the condition of the field, but drains two feet deep and about 20-25 feet apart would probably be sufficient. Apart from the value of drains as a measure of controlling the disease there is another possibility to be considered. Soil which is damp enough to form a favourable medium for *Rosellinia*, is probably much too damp for the normal or optimum growth of arrowroot.

It should be borne in mind that drainage can obviously be regarded only as a preventive measure, and will not effect the cure of plants already diseased. Not only will it be necessary to see that the land is drained before it is planted, but also that the planting material is free from disease.

The writer believes that the distribution of *Rosellinia* in St. Vincent is much more general than is indicated by the presence of "burning" disease, and that owing to the parasitic nature of the fungus being determined by soil conditions, strict precautionary measures to prevent other areas from being infected would be a waste of time and money.

II—Cigar or Long Root.

THE type of rhizome known to arrowroot growers as "cigar" or "long" root was first observed by Mr. T. M. MacDonald on Wallilabo Estate in 1886. Mr. MacDonald having noticed that the waste water from the estate starch factory frequently contained a good deal of slime, concluded that it contained nutrient materials which might be of use if applied to his fields. Consequently a field of arrowroot below the mill was irrigated with this water. The first crop after irrigation consisted almost entirely of thin attenuated rhizomes ("cigar-roots"). After two years it was found necessary to discontinue arrowroot growing in the field and Guinea grass was planted. In the meantime, however, "cigar-roots" were observed on other parts of the estate, and it was thought that a new disease had made its appearance and was spreading over the island.

"Cigar-root" was first recorded in 1900 by A. Howard (5) who stated that the rhizomes of affected plants were thin and attenuated, with long internodes and containing little starch. He found the cells of the older affected rhizomes contained starch grains in all stages of corrosion, which he attributed to the presence of fairly large bacteria observed in many cases to be closely applied to the corroded grains. He also observed that the slime in the waste water was composed of masses of a small unbranched filamentous bacterium, and concluded that this organism was the probable cause of "cigar-root." The bacterium, however, was not isolated by Howard, and his report merely suggests it as the cause of the "disease." Since 1900, nothing has been published on "cigar-root" except a brief description by Nowell (1), who apparently obtained his information from Howard's report.

During the present writer's visit to St. Vincent "cigar-roots" were found to be of fairly general distribution throughout the island. A field which is planted with arrowroot for the first time for several years seldom produces "cigar-roots" during the first and second years (plant and 1st "ratoon" crops), but the number of attenuated roots appears to increase with each successive "ratoon." Certain fields, however, and certain estates are much more liable to produce "cigar-roots" than others. Although the incidence of the affection cannot be said to be intimately connected with any particular type of soil, it is perhaps greater on some of the drier soils of volcanic origin on the Leeward and Windward Coasts. An attempt was made to determine firstly what "cigar-roots" actually were, and secondly what factors were responsible for their appearance. Arrowroot rhizomes were found to vary considerably, the principal variations being in length, in diameter, and in the length of the internodes. There was a gradual gradation in the diameter of rhizomes from about 1/10 inch up to about 1¼ inches. The stouter rhizomes possessed either long or short internodes, and owing to their containing large stores of food reserves (chiefly starch), the proportion of fibre was comparatively low. The thinner rhizomes which are known as "cigar-roots" usually contained little starch, the amount of fibre was large, and the internodes were generally long. Owing to the gradual gradation from thin "cigar-roots" to stout rhizomes, however, it is impossible to state whether some of the rhizomes of intermediate size are "cigar-roots" or not. Frequently both thin and fat rhizomes are produced by the same plant, and a fat rhizome was seen on several occasions to have grown as a side shoot from a rhizome which would be undoubtedly classified as a "cigar-root." Still more interesting is the fact that a "cigar-root" may continue growing to produce a distal portion which is stout although the proximal end remains attenuated.

Although there is some evidence that plants with "cigar-roots" are not so vigorous as others, and that their period of vegetative growth is somewhat extended so that they continue growth after other plants have matured, there is no definite symptom by which the "affected" plants can be recognised unless the rhizomes are examined. The leaves, stems, roots and rhizomes exhibit no symptoms such as are usually produced by bacterial, fungal, or virus diseases. Moreover numerous hand-made sections of "cigar-roots," and roots of affected plants have been examined microscopically, and in no case was there any evidence that an organism was concerned, nor was there any sign of corrosion of starch grains such as Howard reported.

In the light of the writer's observations, it is thought that the production of the condition known as "cigar-root" is not due to parasitic organisms, but rather stands in a definite relation to certain soil factors, such, for example, as a deficiency in mineral constituents. The operation of such factors, being inimical to normal formation of starch, results in a failure of the rhizome to expand and so leads to the development of the

various subnormal spindle-like structures observed. Moreover it is suggested that "cigar-roots" were present before 1886 but that they received no special attention until they appeared in that year in unusual quantity. Subsequent to their once having become conspicuous, however, they would be observed also in other fields, and it is easy to imagine that an idea might originate that an infectious disease was concerned.

It is probably not sufficiently realised that arrowroot is a very shallow rooted crop and as a result, its demands of nutrients per unit volume of soil are considerable. The rhizomes penetrate the soil very deeply (frequently to a depth of two feet) but these are simply storage organs and do not absorb nutrient materials. The true roots are practically confined to the top four or five inches of soil, and are therefore very shallow when compared with those of most tropical crops. Information received from the Manager of Sans Souci Estate concerning one particular field on the estate affords considerable support to a nutrient deficiency theory. This field was planted up with an unusually large number of "bits", the idea being that very close planting would yield an extra large crop. Later the field was given a top dressing of manure. When the crop was harvested however, it most unexpectedly yielded nothing but "cigar-roots". One result of such close planting would be that there is a greater competition among the plants for soil nutrients, and taking the shallow root-system of arrowroot into consideration, it is believed that this competition effect was responsible for the production of "cigar-roots" in such quantity. On the other hand two planters reported that portions of fields on which animals had been penned produced no "cigar-roots" whereas they occurred plentifully on the remaining portions of the fields which had not been penned.

Probably the best field of arrowroot examined was on alluvial soil at Diamond Estate. The plants were growing thickly and vigorously to a height of five feet, the rhizomes were chiefly produced in the upper layers of the soil, and there seemed to be but few or no "cigar-roots" present.

Recommendations.

In view of these facts the writer recommends the adoption of an organised series of manurial trials in which various treatments with nitrogenous, potash and phosphatic manures are replicated and randomised, and the results subjected to statistical analysis. It seems probable that applications of potash would prove to be very advantageous, not only because volcanic soils are frequently deficient in this element, but because potash appears to be of primary importance in the mechanism of the production of carbohydrates, and its application to other starch-producing crops has frequently proved to be invaluable.

It is of interest that Sir John Harrison analysed two samples of soil from Wallilabo Estate, St. Vincent, in 1895, and found that the noticeable difference between a "fair" and a "poor" arrowroot soil was in potash content. The following figures are taken from his certificates of analysis:

		Potassium oxide.
Poor arrowroot soil	...	.114 per cent.
Fair arrowroot soil	...	.181 do.

Although these figures represent "total" and not "available" potash, it is worthy of notice that the "fair" soil contained 67 per cent. more potash than the poor soil. Further, the results of manurial experiments conducted in St. Vincent by Dr. Harland (6) on Sea Island Cotton show that the yield of seed per acre was greatly increased by applications of potash. Whether the soil is deficient in potash as far as arrowroot is concerned, should be determined by proper manurial experiments as suggested above, the aim of which should be devised to ascertain what would be the most economical combination of manures to use.

The steep nature of many of the St. Vincent fields, coupled with the present method of "down-hill" hoe cultivation, are undoubtedly causing much of the best soil in the island to be buried at the foot of the hills. Alternate methods of cultivation which would prevent this loss of soil are obviously desirable, but, as far as can be seen, would involve great practical and economical difficulties.

The selection of planting material ("bits") is another means by which the production of arrowroot might be increased. The "bits" are generally planted back at the time of digging and usually consist of the "heads" or proximal ends of the rhizomes, which are small in diameter, and consequently contain little food reserves. As the result of this, practically all of the rhizomes containing much starch are sent to the factory. This not only allows the planter to obtain a larger yield of starch per acre for that particular crop, but the labourers who are paid by the weight of roots brought to the factory, receive better wages. This system of paying the labourers actually encourages them to plant "bits" of the "cigar-root" type, which on account of their small content of food reserves, are probably incapable of producing vigorous plants. The writer would therefore recommend the system already adopted on some estates, of paying the labourers to bring the whole crop to the factory, and to plant up the field at a later date with selected "bits" perhaps from another field. It is further recommended that experiments be carried out to determine what portion and size of rhizomes are best for planting.

Acknowledgments.

The writer wishes to express his thanks to His Honour the Acting Administrator for his interest and hospitality, to the Agricultural Superintendent and the Chairman of the Arrowroot Association for the arrangement of transport, and for other valuable assistance, and finally to members of the planting community for their willing co-operation and hospitality.

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A VARIETY TEST ON SUGAR-CANE.

[*Being a continuation of the experiment reported by Professor Wood in "Tropical Agriculture" Vol.* IX, No. 9, p. 290.]

By D. D. Paterson.

As already mentioned in the published report of the plant cane results (1), this experiment was designed to test the relative merits under Trinidad conditions of eight popular varieties of thin cane. Uba was included as the standard thin cane type grown in the Island, and also one noble cane, P.O.J. 2878, was added, making nine varieties in all. This P.O.J. 2878 is a recent innovation in the West Indies and one which, from the point of view of high yielding ability and general virility, compares favourably with most of the thin cane types. Conclusions based on plant cane results (1) only, showed that P.O.J. 2878 was the best yielder both for cane and sugar, and that CO 213 was a close second to it. Of the remainder, M 36 and P.O.J. 36 were decidedly above average, and three of the other four varieties were about equal to Uba cane, either slightly better or slightly worse, with P.O.J. 234 a long way behind. The standard variety, Uba, did not take a high place in order of precedence. In regard to sugar percentage, *i.e.*, quality of cane, the best varieties were P.O.J. 213, and CO 281, which, as usual with sweet canes, did not rank among the best yielders of the types under test. The site and layout of the experiment have already been described (1).

The first ratoon crop, with which the present report is concerned, was given the ordinary Trinidad cultural treatment, namely, ranging of the trash, intercultivation between the rows of the young tillers, and a dressing of approximately 1 cwt. of sulphate of ammonia per acre. Heavy winds and severe rains in October and November 1932 caused an abnormal amount of lodging in the crop, particularly in the P.O.J. 2878 variety. This led to a good deal of rotting among the fallen canes and to the growth of fresh suckers which had very little chance of maturing properly before harvest. The season was therefore not an ideal one for the production of high yields of cane or sugar.

Table I.—Yield of Plant Cane and Sugar per acre for 1st Ratoon Crop.

Variety.	Yield of Canes.		Yield of Sugar.			
	Tons per acre.	Percentage of Yield of Uba.	Tons per acre.	Percentage of Yield of Uba.	Relative Position for Sugar Yield.	Percentage of Cane Yield.
CO 213 ..	33.8	129.5	2.82	127.4	2	8.4
M36 ..	32.5	124.5	2.60	117.6	5	8.0
P.O.J 36 ..	30.6	117.2	2.80	126.5	3	9.1
P.O.J. 2878 ..	30.3	116.1	3.06	138.1	1	10.1
Uba ..	26.1	100.0	2.21	100.0	8	8.5
P.O.J. 213 ..	25.8	98.9	2.72	122.9	4	10.6
CO 281 ..	23.0	87.9	2.33	105.4	6	10.1
P.O.J. 826 ..	20.3	77.8	2.30	103.9	7	11.4
P.O.J. 234 ..	20.1	77.0	2.18	98.4	9	10.8

Discussion of Results.

(*a*) *Cane Yields.*

Analysis of variance applied to the yield data for the ratoon crop gives a calculated value of Z of .9477 as compared with 0.6272 read from Fisher's Table of Z (3) for a Probability = .01.

This proves that a clear significance exists between varietal yields, and differences between any pair of varieties greater than 3.3 tons per acre are significant (t = 2.080 for P = .05). The ratoons can therefore be graded as follows :—

1st Class Yielders.	*Average Yielders.*	*Poor Yielders.*
CO 213	Uba	CO 281
M 36	P.O.J. 213	P.O.J. 826.
P.O.J. 36		P.O.J. 234
P.O.J. 2878		

It is of particular interest to note that this classification of the ratoons is an *exact* reproduction of the relative merits of the variety as shown by the plant yields. Varieties that gave a high yield from the plant crop have maintained their superiority in the first ratoon crop. This means that, up to date, there is no difference in the relative ratooning abilities of the different varieties. As is to be expected, the ratoon yields per acre are lower than those from the plant cane crop, the average for all varieties amounting to 65 per cent. of that of the previous year.

(*b*) *Sugar Yields.*

In spite of the very marked difference between cane yields of the first ratoon crop, analysis of variance applied to the sugar yields showed no significant difference between varieties when the Z test was applied. It is possible that the sampling technique, used to obtain material for chemical analysis, when applied to a crop that has been badly laid and is very variable as regards maturity of cane, is not sufficiently accurate. The same method of sampling was adopted in connection with the plant cane crop and was quite satisfactory. Another explanation of this rather negative result from the sugar yield figures might be mentioned. This is the fact that the sweeter varieties tend to be the lower yielders so that in calculating the sugar yields per acre the extremes more nearly approach the general mean of all varieties, differences between varieties are relatively smaller and therefore more difficult to prove statistically.

Assuming that the calculated sugar yields represent even approximately the true sugar values of the varieties, it can be stated with confidence that those giving high yields of cane also give high yields of sugar per acre. This is not due to the fact that such varieties are always high in sugar content. On the contrary, in several cases they are definitely poor quality canes, as for example, CO 213 which ranks second in sugar yield per acre in spite of having a sugar content of only some 8.4 per cent. of the cane yield.

The last column of Table I shows that there are very decided differences in the quality of the ratoons from the different varieties. Five of them give promise of yielding over 10 per cent. of sugar: this group includes P.O.J. 2878 which has rather a poor reputation in Trinidad for milling quality. While 10 per cent. is not a high sugar yield from a ratoon crop it is fairly satisfactory when combined with good yielding ability and undoubted hardiness under trying field conditions. Uba, CO 213 and M 36 are all exceedingly low in sugar content and would not be received with favour by many factories. Therefore, in spite of having given a high yield in both the plant and first ratoon crops, CO 213 is probably an unsatisfactory variety on account of its poor sugar quality.

One other point is worthy of emphasis and that is the relatively poor position that Uba holds when compared with the other thin cane varieties as regards both quality and quantity. This is somewhat surprising as, in a previous varietal experiment (2) in which fourteen well known types of cane were compared under similar conditions on the College Farm, Uba took second place in yielding capacity. It is impossible to say at this stage whether the other thin canes tested in this experiment are equally hardy under Trinidad conditions or whether they will maintain their supremacy over Uba in the later ratoon crops. As this is merely an interim progress report of an experiment that is being carried on for at least another crop, the combination of the data from the different crops is being left till the last harvest has been taken and a final summing up of the relative merits of the varieties can be given.

In conclusion, the writer wishes to acknowledge his indebtedness to Messrs. O. S. Milburn and A. V. Coombs, Post-Graduate Students at the Imperial College during 1932-33. It is from their draft theses that the information embodied in this note has been culled, and it is they who are responsible for the collection and analyses of the field data, a task of no mean magnitude.

References.

1. Wood, R. C.—*Tropical Agriculture*, Vol. IX, No. 9, p. 290.

2. Wood, R. C. and Paterson, D. D.—*Tropical Agriculture*, Vol. IX, No. 1, p. 14.

3. Fisher, R. A.—*Statistical Methods for Research Workers*, London, 1928.

CACAO RESEARCH.

The Second Annual Report on Cacao Research, 1932, 52 pp. + 4 Plates + 34 Figures has just been issued. This publication (price five shillings) which records the botanical and chemical investigations carried out under the Cacao Research Scheme may be obtained on application to the Editor, *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

PRELIMINARY OBSERVATIONS ON THE STORAGE OF LIMES WITH A NOTE ON THE KING ORANGE.

By C. W. Wardlaw and L. P. McGuire.

[*Low Temperature Station, Imperial College of Tropical Agriculture, Trinidad, B.W.I.*]

Introduction.

The need for expanding the market for limes in Great Britain has now been appreciated for some time*. In 1932, approximately 95 per cent. of the green limes exported from the British West Indies was sold in the United States, and at present only a small percentage is disposed of to British and Canadian consumers. As production from this crop is on the increase, not only in the British West Indies but also in the Gold Coast, and as the concentrated lime-juice industry has undergone a serious decline†, it is essential that new markets should be opened up and developed. Accordingly it has been suggested that serious efforts should be made to popularize fresh limes in Great Britain. Some take the view that they should be offered on the market, not as yellow fruit competing with the inexpensive Sicilian lemon, but as green fruit. "The public must be taught to learn that the lime stands in a class by itself for its flavour and refreshing properties, and also to appreciate that the fruit is at its best when it is full grown, green, and only just beginning to show signs of turning yellow" *. Others, again, are of the opinion that in addition to marketing fresh green limes, there is the further possibility of establishing a trade, at certain seasons, in yellow limes. This hopeful alternative should not be neglected, for while it is true that lemons can be marketed more cheaply, a comparison of the juice content and quality of the two fruits would undoubtedly be favourable to well-selected yellow limes.

Such considerations and the cognate publicity requirements, however, fall properly within the sphere of the several business agencies responsible for the export and distribution of this commodity. The aspect with which we are primarily concerned refers to the physiological behaviour of limes with a view to ascertaining the optimum conditions for their overseas transport and subsequent distribution. In short, the time has come when detailed storage investigations should be undertaken, the more so as limes hitherto marketed in Britain have proved somewhat disappointing in respect of keeping quality.

With a view to furthering this useful potential export industry, a comprehensive programme of experiments is being undertaken at the College Low Temperature Station to determine :—

(i) the correct stages of maturity at which to pick for (*a*) green lime markets and (*b*) yellow lime markets ;

(ii) temperature and humidity relationships covering the period of transport and distribution;

(iii) temperature requirements to prolong the marketing season;

(iv) physiological behaviour of the several different varieties which may be exported, viz.: the West Indian lime and the new Trinidad hybrids ;

(v) the best methods of wrapping and crating ;

(vi) the control of wastage.

* Editorial. The Future of the Lime Industry. *West India Committee Circular*. Vol. XLVII, No. 879, June, 1932.

† Manufacturers now prefer to make citric acid direct from sugar : as a result the demand for concentrated lime juice has practically ceased.

Preliminary Storage Trials.

The results of a few preliminary storage trials may be cited here in illustration of some practical aspects.

(1) *Unwrapped West Indian Limes.*—Unwrapped West Indian limes—a mixed consignment varying from small, dark-green, relatively immature fruits, to those showing some yellow colour—were spread out on a tray and held at 45°F. for 20 days. The following records were obtained, Table I.

Table I.

More mature fruit, *i.e.*, showing some yellow colouration after 20 days at 45°F.

Sound fruit	88 per cent.
Desiccated	8 per cent.
Fungal wastage	4 per cent.

Notes.—Fungal wastage was due to *Penicillium italicum*. In the eight per cent. rejected because of obvious external desiccation, the juice content, on cutting, appeared to be practically undiminished. In such fruit, uncrated, unwrapped and fully exposed to cold-air refrigeration, a slight desiccation was characteristic of the whole consignment. Some of the fruits, however, were in perfect condition, indicating that there is a stage of maturity at which a longer period in cold storage may be expected without undue loss through shrivelling.

Less Mature Fruit.—This category consisted of fruits ranging from immature small limes to those which were almost full-grown but still dark green. The latter were in good condition after 20 days at 45°F. The more immature the fruit, the greater was the desiccation. Fungal wastage was negligible as *P. italicum*—the principal storage pathogen—is most active as final maturity is being approached.

(2) *Wrapped and Crated West Indian Limes.*—West Indian limes, picked at two stages of maturity, (*a*) full-grown but green and (*b*) turning

(colouring), were wrapped and crated by the Co-operative Citrus Growers' Association, and then held at 45°F. for 25 days. The records are shown in Table II.

Table II.

Category.	Green.	Turning.	Ripe.	Reject.
Crate 1 Picked Green	30	42	21	7
Crate 2 Picked Turning	0	32	58	10

The following points may be noted:

(i) Provided fruit is carefully wrapped and protected in suitable crates, the West Indian lime possesses good keeping qualities when held at a temperature of 45°F. The wastage recorded was chiefly due to *Penicillium italicum* on the more mature fruits.

(ii) In respect of uniformity, both packs showed some unevenness. The need for careful selection to satisfy the requirements of an industry either in green or in yellow limes is clearly indicated by these figures: for the former, a slightly less mature stage would be more suitable, while, for the latter, fruit should be more fully coloured at the time of picking.

(3) *T1 Limes.*—Consignments of T1 limes*, picked green, were washed, wrapped and crated by the Co-operative Citrus Growers' Association and then held at 45°F. in our storage rooms for 16 days, with the following results, Table III.

Table III.

	Green.	Turning.	Ripe.	Wastage.
Crate 1 ..	17	27	54	2
Crate 2 ..	17	32	49	2

It is clear from the small percentage of wastage that this variety has good keeping qualities when suitably protected from desiccation. For an industry in green limes, such consignments were obviously too mature, while for a yellow lime industry the 17 per cent. of green fruit would detract from the uniformity of the pack, again indicating the need for careful selection and grading.

Other samples of T1 limes (crated green and turning) were held at 45°F. for 18 days, then transferred to 70°F. for three days, Table IV. The effect of this treatment was to accelerate ripening: wastage due to dehydration was slight. Again, unevenness of colouring was a feature of these packs.

While it is not proposed to draw more detailed conclusions from these preliminary storage trials, the records which have been cited indicate that further low temperature investigations with green and yellow limes are likely to be attended with useful practical results.

* A Trinidad hybrid between the West Indian and the Philippine lime.

Table IV.

	Green.	Turning.	Ripe.	Wastage.
Crate 1 Crated Green	52	46	0	2 (dehydration)
Crate 2 Crated Turning	0	53	42	5 (dehydration)

Storage Behaviour of the King Orange.

The King Orange or Giant Mandarin (a variety of *Citrus nobilis*) as the name indicates is a large form of the mandarin or portugal. It is characterised by a loose skin which can very readily be removed, and by the deep orange-coloured flesh which is remarkably juicy and sweet.

Experimental consignments of the King orange were picked at two stages of maturity:

(*a*) medium sized fruit with skin still green and smooth, and

(*b*) larger, more mature fruits, with skin orange-yellow in colour and rough, warty or rugose in texture.

These were placed in cold storage at 45°F. Even when exposed unwrapped to refrigeration by the cold air blast system, both categories showed remarkable keeping qualities at this temperature. After 30 days the entire consignments were perfectly sound; the green fruits had acquired a little extra colour; dehydration was not apparent and flavour was excellent. In the more mature grade, some of the large coloured fruits showed signs of slight desiccation.

With sampling at intervals, the two lots were held at 45°F. for 60 days in all. It was only towards the end of this period that some of the green fruits, whose colouration had only increased to a minor extent, showed slight dehydration in the form of minute cracks; the fruits, however, were still heavy, full of juice and of good flavour. In the more mature grade, the final decline, accompanied by slight fungal activity, had set in and the juice had lost its sweetness and flavour.

From this storage trial, in which unprotected fruits had been subjected to a severe test, it is clear that no difficulty need be anticipated in the refrigerated transport and storage of the King orange, if picked full-grown but green or only slightly colouring at the stylar end. The larger more mature grades also possess good keeping qualities: if well selected, such fruits have an attractive appearance and might find a special place in the market, like the red banana, for decorative purposes—a circumstance which would offset the higher packing and freight charges consequent on their large size.

The writers are much indebted to the Officers of the Trinidad Agricultural Department, to Mr. H. Rapsey and to Mr. G. F. Huggins, O.B.E., for supplies of fruit and for their helpful co-operation in this work.

CULTIVATION AND DISEASES OF THE BANANA IN BRAZIL.

By C. W. Wardlaw and L. P. McGuire.

[*The following account of cultivation and diseases is based on investigations in the State of Sao Paulo, Brazil.*]

PART I.—CULTIVATION.

1. Topography of the Banana Lands.

The Banana lands in the State of Sao Paulo are situated on alluvial areas lying between the sierra and the sea. They owe their formation to the action of rivers and streams descending from the steep eastern slopes of the coastal mountain barrier to the Atlantic. As the rivers follow a meandering route to the sea, various grades of soil material, derived from the granitic hinterland, have been deposited.

The banana lands are mostly approached and are sometimes only accessible by water, and as one traverses the much branched, tortuous channels an excellent opportunity is afforded for studying the succession of vegetational types from sea-level to the point where the alluvium is sufficiently raised to permit of cultivation. Black mangrove mud flats, completely under water at high tide, are succeeded by slightly higher land supporting low bush and prickly species of palms. A little higher up a ground vegetation of sedges, ferns and grasses secures a foothold. Finally, on proceeding further inland, alluvium, sufficiently high above the water-table to permit of drainage is encountered. In its virgin state this carries bush of moderate height, and is, in the undrained state, constantly moist and under water during wet weather. As a rule the better classes of alluvium occur at some distance from the river banks.

Seen from a point of vantage the banana lands present an interesting spectacle. They consist of relatively broad valleys penned in by spurs running down from the steep face of the Sierra (Figs. 1, 2 and 4*). They are traversed at various points by meandering rivers and streams whose courses are outlined by the dark green fringe of mangroves. Here and there different shades of colouration in the vegetation indicate variation in the soil deposits or the position of old river courses. At some points the surface of the plain is interrupted by characteristic mounds distributed in linear succession. These consist of an impoverished red earth of a different consistency to the typical alluvium and are most probably moraine deposits accumulated during the period of glaciation. Evidence of the latter is also afforded by the occasional presence of large polished and scratched, isolated boulders.

2. Climate.

The banana areas receive on the whole about 180 to 220 cms. (78-88 inches) of rainfall per annum, which falls little short of the generally accepted optimum for bananas. It will be recalled that in areas of Jamaica and Colombia, where irrigation is the rule, irrigation water is supplied in quantities to approximate to 100 inches per annum. Table I gives the monthly rainfall and monthly maximum and minimum temperatures. It will be seen that May to September are the dryer and colder months, during which there is comparatively little growth of the parent plant and slow development of the formed bunch.

Bananas are grown principally at sea level though on several farms, operations have been extended up the hills to 200 metres. Small holders' plantations are sometimes found at these heights.

In several areas wind is prevalent, as evidenced by the fraying and tearing of leaves, but the "blow-down" of Jamaica and Colombia has apparently not been experienced in the Santos districts. No windbreaks therefore have been planted.

3. Commercial Varieties.

The chief varieties exported are the Ananica (Cavendish) (Fig. 3), and the Mestica (Fig. 1) which, from a consideration of bunch habit, shape of fingers and behaviour in storage trials at Santos seems to be the Grenada Giant, though on ripening the departure from original symmetry was not so marked as, and the flavour more pleasing than, in the fruit on which our earlier experiments were conducted in Trinidad (1). The market's main objection to the Mestica seems to be the size of the individual fingers when compared with those of other varieties. (Fruit is sold to the brokers by the ton but the small man retails at so much per dozen.)

These two varieties seem to differ from the Trinidad Governor and Giant Fig only in general plant vigour, presumably as a result of more favourable nutritional conditions, soil and climate.

The marked effect of nutritional conditions on the general well-being and longevity of so many fruits in cold storage may possibly account for the differences of flavour, colouring and symmetry.

4. Soils and Cultivation.

Banana cultivation on a smaller or larger scale has been attempted on what may, for convenience, be divided into three soil types. These are (1) "tabatinga", (2) alluvial loams and (3) hillside soils. While all are essentially derived from the same source, their mode of formation, situation and the type of virgin forest finally

*Figs. 1, 2 and 6 by courtesy; the others by C.W.W.

(1) Wardlaw, C. W. and McGuire, L. P.—The Behaviour and Diseases of the Banana in Storage and Transport.—*Empire Marketing Board*, Report No. 36, H.M.S.O., 1931.

developed, have induced changes which make for great differences in their ultimate condition as judged from the viewpoint of practical agriculture.

(1) *Tabatinga.*—This soil type, of alluvial origin, consists of fine silt or clay deposits which occur in immediate proximity to the mangrove mud flats. Such land lies just sufficiently above high tide level to permit of drainage; in some areas embankments and flood gates are necessary to facilitate drainage operations, and in point of fact in most of the "tabatinga" soils examined the water-table was close to the surface.

Where adequate drainage can be secured "tabatinga" soils are exceptionally fertile and produce very good fruit. An examination of the distribution of the banana root system showed that the vigorous growth achieved depends almost entirely on the fertile superficial layer of humus-laden top-soil. A typical profile may show 5-10-12 inches of spongy top-soil, composed very largely of vegetable debris, in which vigorous rooting, with abundant formation of laterals, is achieved. Proceeding downwards, there is a rapid transition to a very compact, soft, water-logged bluish clay or fine silt in which root development is scanty or entirely absent. As a rule downwardly penetrating roots quickly become diseased and suffer from die-back. The subsoil likewise bears little evidence of having been penetrated by the roots of the original bush plants.

The high fertility of "tabatinga" soils is, therefore, referable to the layer of fertile top-soil. When this shrinks after a number of years of drainage and cultivation, production tends to fall off rapidly. The better areas, with 10 to 12 inches of top-soil, are said to yield satisfactorily for 12 to 15 years.

From the standpoint of plant growth, "tabatinga" soil presents a number of anomalies. Thus, while root development takes place rapidly with abundant production of laterals, it is noticeable that the latter are very short-lived and quickly become limp, bluish in colour and subsequently diseased. Main roots also readily undergo deterioration and a considerable amount of root rot is the rule even in the most vigorous plants. As new roots are quickly formed to replace the decayed ones, a high production of good class fruit is, nevertheless, obtained. At this point it may also be mentioned that bacterial wilt disease is more severe on this soil type than on typical loamy soils. In general "tabatinga" reminds one of the pegasse deposits encountered in the Guianas. Some experiments on root-development in "tabatinga" soils are described in a later section.

So far little has been attempted in the way of implemental tillage of "tabatinga" soils. On some private properties the blue clay removed from the drains is systematically spread over the plantation floor and old plantations treated in this way enjoy a slightly prolonged period of productiveness. While this may be profitable when carried out by families of small cultivators, it is of doubtful economic value in large scale operations.

The "tabatinga" sub-soil undoubtedly contains large reserves of plant foods provided these can be rendered available by drainage, aeration and oxidation, while heavy liming and the incorporation of adequate quantities of organic matter are obviously necessary to avoid reversal to the original condition.

Some experiments were carried out in which (1) sub-soil was thrown out in lumps and left exposed, (2) sub-soil and top-soil in equal proportions were intimately mixed, and left exposed, and (3) sub-soil and top-soil in equal proportions were intimately mixed, and a heavy dressing of lime incorporated. The results, which were of very considerable interest, demonstrated clearly that this apparently intractable soil is capable of very marked improvement. Taken in order it was found after some 4 to 6 weeks exposure that in (1) the sub-soil cracked, crumbled, changed colour and became moderately friable; and (2) a good, but rather sticky and retentive black soil was produced, while in (3) a black soil of excellent texture was obtained. While it is not suggested that the latter procedure lies within the economic limits of the industry, the results nevertheless show that "tabatinga" soils, which have declined after a period of productiveness, are capable of responding to suitable treatment. A point worthy of emphasis is that where such a treatment is contemplated, it should be carried out before too much of the surface organic matter has been depleted by continuous production over a number of years.

(2) *Alluvial Loams.*—The greater proportion of the banana soils are light to medium loams, of typical alluvial origin, being derived from the white granite rocks of the sierra. They have been deposited by winding rivers. At their worst they become too light and sandy; at their best they are good retentive loams, in which the amount of clay, as determined by inspection, is seldom great. In their virgin state they are covered by dense bush of medium height, and are well supplied with humus. Good drainage is the rule on such soils, and in most areas production, based on the Central American system, has been good for 15 years and upwards. When subjected to deep implemental tillage the alluvial soils show a marked response in subsequent plant growth. Here the chief difficulty lies in the preliminary levelling operations. Thereafter deep ploughing is easily achieved if heavy tractors are used. In Brazil, however, such operations are still in the experimental stage. The alluvial valleys are broad and extend a considerable distance inland, *i.e.*, from the "tabatinga" marginal soils to the base of the sierra. In one

valley, for example, some 4,000 acres are under bananas, or are being taken into cultivation at the present time (Fig. 2).

As a considerable number of such areas exist in an untouched state along the coast line, the position of Brazil as a possible source of bananas during the next 20 years cannot fail to be a matter of very considerable interest to all concerned with the banana industry. The drawbacks to the alluvial soils are liability to floods and drainage difficulties (*i.e.*, some areas are not sufficiently high above the water-table especially, at high tide).

(3) *Hillside Soils.*—As a rule these soils are much less fertile and active production is usually estimated at approximately 4 years. The soils may be rather stiffer than the alluvial soils of the plains, or they may be coarse and gritty, being formed of scree material. Under the prevailing high rainfall they suffer from washing and erosion. In the more up-to-date plantations some contour drainage is being contemplated. These hillside areas are very steep and rough and fruit is brought out with difficulty. Pulley systems have now been installed on some farms (Fig. 9). Even though the life of such soils is short, large hillside areas have been opened up since (1) production over 4 years is regarded as a good return for cutting the bush and planting, (2) concessions generally extend up to the ridge of the hillsides and if not used represent a considerable loss of acreage, (3) up-keep is cheap since no draining operations are undertaken and (4) clearing the lower hillsides has the effect of opening up and aerating the plain to some extent. (Figs. 1, 2 and 5.)

In planting new lands the procedure is very similar to that in operation in Central America (1). The underbush is cleared, main drains excavated, the banana "bits" planted and finally the heavy timber trees are felled (Fig. 6); in due course the young banana plants emerge from the mass of decaying branches and trunks and fruit may be reaped in 12-15 months. When old plantations, upon which little has been expended for up-keep, are being renewed, main and lateral drains are cleaned, the existing stools pruned, and supplies planted where necessary; in some instances, the existing mats are dug up and the whole area replanted so that high productivity is re-established. On some farms experiments on the intensive cultivation of apparently exhausted soils (*i.e.*, after 15 years continuous banana growing) are in progress. The old stools are dug up, the ground levelled, tractor ploughed, disc-harrowed and ridged, the "bits" being planted on the ridges. That the banana has responded to such soil treatment is evident on comparing old fields with the cultivated and replanted areas (Figs. 7 and 8). Experiments on the maintenance of fertility by the use of cover crops are also being considered.

(1) Wardlaw, C. W. and McGuire, L.P.—Reports on Scientific Visits to the Banana Lands of Central and South America.—*Empire Marketing Board*, Report No. 20, H.M.S.O., 1929.

The "bits" are usually planted in holes 15 ins. diameter by 15 ins. deep, set at 10ft. by 10 ft. or 10 ft. by 11ft. though occasionally plants may be set at 8 foot intervals in rows which are 12 ft. apart. Such close planting of vigorously growing plants may contribute materially to the stuffiness and humidity of plantations.

The usual planting "bit" consists of two good "eyes" both of which are allowed to develop in good soil, but only one in poor soil. Occasionally in the former, three-eyed "bits" may be used but only two are left to mature.

Pruning operations are proceeded with at the commencement of the cold weather (April, May) and of the hot weather (October), and at these times the whole sucker is completely removed by means of an implement of the mattock type.

Cleaning operations are carried out once every three or four months, and at the same time, where necessary, unwanted suckers are trimmed. In good soil two suckers are left but in the poorer types of soil, and in the old plantations, only one sucker is left and that usually on the inside of the mat for the sake of alignment. Failures are replanted in December and January so as to "shoot the bunch" in warm weather and similarly pruning is directed to that end. With this exception pruning of fruit for definite seasons or for definite months is not practised.

Experiments as to the responsiveness of the banana to applications of pen-manure, green manure or artificial fertilisers have not been undertaken as a commercial operation. On certain poorer parts of an old farm, pen-manure, 3 kerosene tins per mat, or bonemeal ½ tin, has been applied periodically to the poorer stools, with beneficial results. On a certain estate, which with occasional replantings has been in production for 25 years, pen manure had been applied with marked improvement.

5. Yields in Number and Size of Bunches.

On several properties consistent production of 600-700 bunches per acre of seven hands and upwards was obtained in the third year. Planting 10 ft. by 10 ft. gives 360 stools per acre which, allowing two plants per stool gives 720. On the other hand, a plantation 10 years old gave 440. Table II gives monthly production from five areas on what was by no means an outstanding good farm. It is interesting to correlate the fall in production with the decrease in monthly rainfall and the lowering of minimum temperatures during the cold weather (*cf.* Tables I and II).

It is interesting to note that abandonment is seriously considered only when production falls to 100 count bunches per acre, *i.e.*, bunches of 8-hands, since recently the export of 7-hand bunches or less is prohibited by Brazilian Law.

6. Fruit Cut, Transportation and Stowage.

The principal countries to which Brazilian bananas are exported are the Argentine, England and the Continent. Fruit for export to British

Table. I.

Month.	Locality I.			Locality II.			Locality III.		
	Temperature. Max. °C.	Min. °C.	Rainfall. cms.	Temperature. Max. °C.	Min. °C.	Rainfall. cms.	Temperature. Max. °C.	Min. °C.	Rainfall. cms.
1932.									
March ..	34	15	17.28	31	15	24.46	32	20	37.9
February ..	36	17	25.17	39	21	25.35	36	22	38.4
January ..	36	14	27.25	36	15	28.67	32	20	28.4
1931.									
December ..	34	13	19.72	34	15	25.57	30	19	31.1
November ..	39	12	19.55	32	13	16.36	28	17	20.3
October ..	32	11	22.62	34	13	22.95	24	16	10.4
September ..	23	9	12.86	28	11	12.70	22	15	8.5
August ..	30	4	2.78	32	9	2.98	24	13	2.9
July ..	31	8	3.35	34	9	3.09	25	13	3.6
June ..	32	3	4.92	30	4	6.82	25	14	4.9
May ..	37	9	12.94	34	9	10.39	27	16	7.2
April ..	35	15	9.51	29	16	10.62	32	19	20.6
			177.95			189.96			214.2

Table II.

Monthly Production of Bunches.

Locality.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
A ..	68	47	102	64	63	22	32	43	37	37	29	72	616
B ..	109	142	67	43	41	22	20	26	13	31	26	66	606
C ..	72	47	58	34	58	0	58	6	45	63	58	76	575
D ..	47	59	79	45	51	0	66	2	32	105	31	48	565
E ..	71	20	34	35	31	18	20	4	24	18	32	24	331

ports may be obtained from the Santos district, *i.e.*, from farms which are from 7 to 40 miles up adjacent meandering rivers, or it may be grown in other valleys situated at some distance along the coast. All fruit is brought by barges to the ship's side for loading. On the farms, fruit is conveyed by narrow-gauge trolley cars, which are either mechanically driven or mule-drawn to the "Ports" where it is loaded on to the barges in three (sometimes four) vertical tiers (proximal end downwards) and one "roller" or horizontal tier on top (Figs. 12 and 13). The same type of stowage is adopted in the ships' holds. Dockside loading is effected by mechanical conveyers, very similar to those in use in Caribbean ports; otherwise the fruit, 20 bunches at a time, is repacked into loading baskets and hoisted by crane.

Refrigeration arrangements on banana boats consist essentially of modifications of the Battery Substitute System.

(1) *Fruit Cut.*—During our stay opportunities were taken for studying the several operations involved in the reaping and transport of fruit with a view to reduction of wastage in cargoes.

From the outset it should be mentioned that we were agreeably surprised at the smooth conduct of operations and the organisation already achieved. In short what is really needed is not the introduction of new practices but more careful supervision of the more important operations. These may be briefly summarised as follows : —

(1) Careful selection of fruit which, after bagging (Fig. 10) and cutting, might be segregated into "larger" and "smaller" and loaded as much as possible at different ends of the barge; bags might be marked with a red or blue pencil to denote one type or the other. This would facilitate the final stowage of cargoes which is dealt with fully below.

(2) Greater care in placing the banana trash padding as a support for the fingers of the proximal hand ("bottom" hand in the Trade terminology). Rough handling in this operation results in the disruption of epidermal tissue of the individual finger stem which becomes at once a potential ingress for the fungal organisms responsible for finger dropping and contributes towards the general unattractiveness of the fruit.

(3) When the paper bag has been secured, the paper should be folded back. This will facilitate inspection, retrimming and treatment of the stem prior to loading.

(4) The actual trimming and painting of the re-cut end calls for comment. (*a*) The cut must be a clean one and it is necessary to use a sharp instrument. The superficial tissues on the under side should not appear torn or frayed at the completion of the cut. (*b*) The trimmer should examine the stem before making the cut. It is quite futile to apply sealing material, tallow, vaseline, &c., to the cut end alone when immediately below it abrasions and mechanical bruises are in evidence on the stalk. These should be carefully pared sufficiently deep to expose healthy tissue and then painted. (*c*) Reduction to a marked extent of the interval between the retrimming operations and the actual loading on to the ship and commencement of refrigeration is recommended.

(2) *Stowage.*—There is considerable room for improvement in the stowage of bunches; it is realised of course that this is a skilled operation and efficiency will be gained by experience and tuition. Fundamentally the first necessity for improvement is dependent on the uniformity of bunches handed to the stower and the tightness of the stowage. Segregation of bunches from the point of view of size has been dealt with above.

The importance of tight vertical stowage, particularly in the lowermost tier, and the stowage in as near the vertical position as possible of the super-imposed tiers (except in the topmost "roller" layer) cannot be emphasised too strongly (1). In the course of the first four or five days of the voyage, the cargo sags from 18 to 36 inches, approximately proportional to weight per unit sectional area. During this process, under conditions of loose stowage, the stalks of bunches of the lowermost tier, coinciding with the gaps in the deck-grating become, under the weight of super-imposed bunches, the so-called "slanting stems" which continue to bend further and finally split, leaving large portions of tissue exposed to fungal attack. On the other hand, under the better conditions of tight stowage described above, each bunch supports, and is supported by, its immediate neighbours, the whole tier receiving peripheral support from the stanchions and bin-boards of each fruit bin. Thus in the sagging process, the tightly packed cargo sinks uniformly as a composite whole, the weight of the cargo being translated through individual bunches along its longitudinal axis—another obvious advantage of the vertical stowage of intermediate tiers. When not stowed vertically, there is danger that the stem is subjected to uneven pressure at different points along its axis resulting in the breaking of epidermal tissue on the stalk between the hands; when rotting commences, the wastage assumes more serious proportions in view of proximity to the hand-cushions ("knuckles") and finger stems which are soon invaded.

There is an entirely erroneous opinion current in Trade circles regarding the magnitude of bruising as a result of the initial tight stowing. If, instead of being merely placed in tiers in the hold, the bunches are forced *with discrimination* into their respective positions, the bruising will be considerably less than with loose stowage, especially if inclement weather is experienced during the earlier part of the voyage when the cargo is settling down. The support given to the main stalks has already been discussed.

The Trade is inclined to the loose usage of such terms as "asphyxiated fruit", "dull or dead fruit", which is ascribed to tight stowage. It cannot be upheld, however, that this result is attributable *per se* to the tight stowage; it is a function of the ship's refrigeration and ventilation efficiency whereby (1) the cargo is cooled expeditiously to carrying temperature, (2) the condition of dormancy, with concomitant low respiratory activity induced, and (3) the thoroughness with which the gaseous products evolved are eliminated. The term "dull" above must not be confused with the term implying the dull colouring of chilled fruit on ripening. Further in actual shipboard experience the so-called

(1) Wardlaw, C. W. and McGuire, L. P.—*Empire Marketing Board*, Report No. 60, H.M.S.O., 1932.

"dead fruit" was, as far as one was able to diagnose from the evidence submitted and from the subsequent behaviour of such fruit, the result of too long a delay between reaping and commencement of refrigeration; incidentally it was more prevalent in fruit purchased from small holders especially in the "blow-down" season.

(3) *Refrigeration.*—The holds inspected were refrigerated by the so-called Battery Substitute System, perfected by Griffiths (1). The air is circulated over brine coils, into marginal trunkways which are fitted with exit ports through which the air passes, cools the fruit, and returns to the suction fan. The carrying temperature is 52.5 to 53°F. and the voyage period 16 to 18 days according to the class of ship. It is realised that the conversion of holds from one type of refrigeration to the other (or its substitute) presents restrictions in the arrangement of fans and trunkways because of the position of bulkheads, hatchways, &c., and in the case in point, one is tempted to speculate on the slowness of cooling of bunches in certain definite positions in the hold. Unfortunately no data on the matter of actual flesh temperatures are available, and without distance-reading instruments would be difficult to obtain since doors from trunkways open inwards into the cargo. Correlation of the amount of wastage with particular parts of the hold should be undertaken in the light of previous work (2) which established conclusively the relation between growth rate of the stalk-rot organisms and temperature. It seems that comparatively inexpensive modifications involving either the alteration of the present course of the cooled air or the use of the brine pipes in a supplementary capacity might be introduced if such observations prove them justifiable.

7. Storage and Ripening Trials.

Some doubt existed as to what variety the so-called mestica, and so-called "Gros Michel" belonged. Accordingly their behaviour in cold storage and subsequent ripening was studied so that their identity might be established. As far as could be determined from storage criteria they were found to be none other than the Grenada Giant Fig. At the same time the behaviour of a new variety, which appears not distantly related to the West Indian Silk Fig, was followed with a view to assessing its commercial possibilities. This variety has a neat and orderly bunch, which on ripening assumes a very attractive yellow colour. It has a pleasing sub-acid flavour, to which the market, however, might need educating. This variety is unfortunately quite as susceptible as the other varieties in the matter of main-stalk rot and "pitting" disease.

(1) Griffiths, A. E. and Davies, R.—Union of S. Africa, Dept. Agric. *Sci. Bull.* 56, 1926.
(2) Wardlaw, C. W. and McGuire, L. P.—*Empire Marketing Board*, Reports No. 36 (1931) and No. 60 (1932), H.M.S.O.

REVIEWS.

AN INTRODUCTION TO TROPICAL SOILS.

By Dr. P. Vageler, translated by Dr. H. Greene. *Macmillan & Co., Ltd.*, London, 1933. *Price* 15*s.*

This extremely interesting and arresting book, written essentially for the practical man, stresses the fundamental differences between tropical and temperate soils, that are due mainly to differences in the rate at which rock-weathering proceeds in the different climatic regions within which these contrasted groups of soils are developed. The treatment in the first part of the book (Chapter II) is broadly geological and mineralogical, though not deeply technical. The value of the descriptive matter here is greatly enhanced by the numerous hints to means whereby tropical soil examination may be extended beyond the limits of conventional physical and chemical analysis. Thus, precise yet simple instructions are given for identifying the specific mineral assemblages occurring in a given soil sample. It is justly maintained that "permanence of fertility of a soil varies with its content of minerals which are still liable to decomposition; a soil having a high content of such minerals, other things being equal, is better than a soil with no mineral reserves" (p. 18). Hence a rapid and roughly quantitative determination of the fresh mineral contents of tropical soils should furnish a reliable index to their fertility.

Chapter III deals with forms of vegetation in the tropics as sources of organic substances in the soil. Soil humus is not only a carrier of readily-available plant nutrients, but also a provider of nitrogen and carbonic oxide. Some astounding facts are given about the quantity of plant litter that may collect in tropical forests, and the great rate at which it decays. The effects of the residues on the underlying soil is described, and the marked differences in these effects, depending on the derivation of the soil from non-calcareous or from calcareous rocks, is amply stressed. Monsoon Forest, Moist Savannah, and Grass Steppe are described in considerable detail.

Chapter IV discusses the effects of climate, topography and vegetation in the formation of tropical soils, and presents many highly interesting facts concerning the control of temperature and soil moisture by the vegetation cover. "Thus, while soil-types of the tropics are in a general way conveniently classified in relation to the atmospheric climate of the region in question, vegetation, distribution of rainfall, local topography and nature of the parent rock have so great an effect on the detailed development of the soil that these secondary influences usually completely mask purely climatic influences, and certainly have a far greater effect in the tropics than in temperate climates." (p. 111.)

The first half of Chapter V discusses the formation of tropical and sub-tropical soils. It deals first with the details of rock-weathering, then with the conversion of organic residues into humus, and the influence of this process on the chemical changes in the underlying soil, and finally with the displacement and redeposition of soil material (erosion, land-slip, alluvial deposits, &c.). The remainder of the chapter is devoted to a full description of the soils that characterise the tropics, (1) under constantly moist conditions, (2) under intermittently moist conditions, and (3) under dry conditions. Outstanding types, such as tropical peaty soils, red loams, red earths, Terra Rossa, grey and black earths, and desert soils are described in turn. Whilst some readers may not agree with Dr. Vageler's explanations of the mode of formation of some of these types, the field descriptions are vivid and very instructive.

Chapter VI is devoted to a discussion of the guiding principles of tropical soil selection for crop-growing. This chapter contains much subject matter of real value to practical planters and agricultural administrators. "Well over seventy-five per cent. of all failures of agricultural enterprises are due mainly, if not entirely, to wrong choice of land" (p. 189); "Most tropical crop plants have far stricter requirements for various definite soil properties than is the case with the majority of crop plants in the temperate zone — the argument that, where natural vegetation is luxuriant, crops must do well . . . is by no means a hard-and-fast rule." (p. 190), and, "poor soil with good transport and trading facilities is better than good soil without" (p. 192). "The depth of soil, and the soil profile in its physical aspect, play an important and often decisive part in respect to all tropical and sub-tropical crops" (p. 193). For these reasons, Dr. Vageler rightly advocates the profile method of soil examination as a means for assessing land suitability.

The last two chapters of the book deal with the choice of crops and the management of tropical soils. Here again, many valuable hints to the planter are given. The importance of cover crops and artificial manures in tropical agriculture is fully discussed, and the specific water requirements of different crops are considered. In the wet tropics, only about twenty per cent. of the rainfall is actually used by the plant, owing to evaporation losses and deep penetration (p. 217). The question of soil acidity, manurial needs, and the peculiar properties of some tropical soil-types, such as the red earths, are discussed in detail in this section.

Dr. Vageler's twenty years' experience of tropical soils enables him to write with authority. He was a soil expert in German East Africa before the War, and afterwards, agricultural chemist at the Dutch Tea Research Station in Java. He has explored Persia, and has recently been working on the soils of the Upper Nile region. His book "conveys a good impression of what tropical soils are really like" (foreword by Sir John Russell), and, as an unacademic presentation, without text-book pretensions, it can be strongly recommended to planters and students of tropical agriculture.

F. H.

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THE METHODS OF CELLULOSE CHEMISTRY.

By Chas. Dorée. *Chapman & Hall, Ltd.*, London, 1933. pp. 482, with Appendix and Indexes. Price 21*s.*

This is a book for the specialist biochemist. It describes "the experimental investigation of cellulose in its various aspects—as a chemical substance, as a structural colloidal unit, and as a primary constituent of plant cells". The details of the methods used, many of which have been evolved by Dr. Dorée and his colleague, Mr. C. F. Cross, have heretofore been available only in a wide literature, including the standard journals of physics, chemistry and botany. The book has been compiled from notes prepared by the author for the use of his students. Full working details of a selection of the best methods are given. The materials dealt with comprise normal cellulose (including mercerised cotton, rayon, oxycellulose and hydrocellulose); synthetic derivatives of cellulose (nitrate, xanthate, acetate and esters), many of which are of great importance in the artificial silk industry, and compound celluloses (lignin, pectin-compounds, &c.), present in wood.

The subject matter includes much information of value to agricultural biochemists, who will be grateful to Dr. Dorée for presenting, in such a concise and useful form, many laboratory methods suitable for application in investigations concerning the breakdown of plant residues during the formation of soil humus, and in the manufacture of synthetic organic manures and composts, as well as in studies of commercial crop products.

F. H.

* * *

PLANT ECOLOGY.

For the Student of British Vegetation. Wm. Leach. *Methuen & Co., Ltd.*, London, 1933. pp. 98 and Index. Price 3*s.* 6*d.*

The Preface states that "the aim of this book is to provide the students of British vegetation with a concise account of the aims and principles of Plant Ecology, and to serve as a guide to the carrying-out of field work in a scientific manner. To have achieved this aim in so small a compass is indeed very creditable, and the author deserves the thanks of time-pressed students for having so ably presented the claims of Ecology on the attention of those whose work in any way concerns growing plants.

A comparatively large part of the little book is devoted to an elementary discussion of soil problems, since it is now recognised that the soil is the most important part of the environment in which plants grow, so that a full understanding of its properties and behaviour, based on a knowledge of its formation, is an essential requisite to the student of Ecology.

F. H.

* * *

The Empire Journal of Experimental Agriculture.

Vol. I, No. 1, April, 1933, pp. 1-96, *Price 7s. 6d. Clarendon Press*, Oxford. Published quarterly; Annual subscription 20*s*.

The first number of the first volume of this new agricultural journal has just been issued, under the editorship of Dr. E. H. Tripp, from the Clarendon Press at Oxford. The publication of this journal is an outcome of the Imperial Agricultural Conference which was held in London in 1927. The Journal is designed to deal with problems relating to crops, soils and animal husbandry in the Empire. In a foreword, the Right Honourable J. H. Thomas, Secretary of State for the Dominions and Minister of Agriculture, indicates that the founders of this new journal have recognised the need for co-operation between those responsible for guiding imperial agricultural policies, and for means of pooling the discoveries of agricultural research workers for the common weal.

The contents of the first issue comprise nine articles, dealing with such diverse subjects as wheat-breeding in Canada, soil investigations in Canada and in Cyprus, grassland management, haymaking machinery, dried grass fodder, residual manurial value of legumes at Rothamsted, nutrition of sheep in relation to stomach worm, and Kentish corn-growing in the Middle Ages. Each of these articles involves fundamental considerations of wide application, and together they deal with practically every representative phase of agricultural science.

The subject matter is clearly and attractively printed and arranged, and the diagrams, illustrations and tables are well presented. The journal bears a similar relation to general practical agriculture as the *Journal of Agricultural Science* (inaugurated in 1905) bears to specialized agricultural research, and, on this account, it should render really useful service.

F. H.

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The S. A. Sugar Year Book and Directory, 1933.

H. O. Andrews. *The S. A. Sugar Journal*. Durban. 8*s*.

The 1933 edition of this Year Book represents the fourth successive year of publication. Fresh material and more printed pages are included, and illustrations are used freely throughout the book. The publication is divided into sections which include, amongst others, Historical, Economic and Statistical, Factory Data, &c., Agricultural, a list of Sugar Manufacturers in Natal and Zululand, Mill Groups and Associations, and a description of each factory. It is completed by a miscellaneous series of paragraphs on important subjects, some of which will prove of use to the practical planter. As a whole, the Year Book is well thought out and put together, and the quality of print and paper is high although a few obvious misprints occur. Its size and usefulness will no doubt grow to even greater proportions with coming issues.

J. G. D.

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The Apple.

By Sir A. Daniel Hall & M. B. Crane. *Martin Hopkinson, Ltd.*, London, 1933. pp. 235. With 2 Appendices and Index. Price 10*s*. 6*d*.

This book makes its appeal, as Sir Daniel Hall states in the Preface, to the practical man. Reasonably short and eminently readable, it makes no claim to being an exhaustive reference book; it is a most praiseworthy endeavour to explain to the grower in the simplest language possible how the work of the scientist—and particularly that of the geneticist—can assist him towards a more proper appreciation of his problems.

In the first half of the book the authors describe the most recent developments in connection with breeding work, and problems of fertility, variability, and allied subjects as they apply to the apple. The work of M. B. Crane himself naturally figures largely in this section, and a very clear case for the application of his cytological studies to orchard and breeding practice is established. The treatment of such technical subjects as genetics and cytology within so small a compass is indeed admirable, and deserves to be read even by those not directly interested in apple breeding or culture. The second half of the book is devoted to essentially practical aspects such as soils, manures, cultivation, diseases, propagation and varieties. These are dealt with very concisely, and with the sole object of drawing attention only to the soundest and most reliable methods of modern practice.

Brevity, and disregard of non-essentials are the keynotes of the book, and will at once commend themselves to those who realise how increasingly difficult it is to obtain precise information on a particular crop. Moreover it presents a definite point of view, and is consequently all the more stimulating. Finally, it is an admirable warning to those concerned in less well-known perennial crops, such as we have in the Tropics, that it requires great caution and the accumulated work of many years before the horticulturist can get the best from his plants.

N. W.

WEST INDIAN NOTES.

(Compiled by the Advisory Department, Imperial College of Tropical Agriculture.)

The Sugar Industry.

St. Kitts.—After some delay due to adjustments of the machinery to cope with a record crop of cane the Basseterre factory did excellent work. Fields on estates situated on the leeward side suffered from prolonged dry weather and as a result the very heavy yields per acre obtained in the early part of the crop fell off. The sucrose in cane and the purity of the juice, on the other hand, have both been highly satisfactory and the total output of sugar for the Island is likely to reach over 22,000 tons.

The Annual Report for 1932 of the Agricultural Department, St. Kitts, which will shortly be published will include some interesting results of the year's work on sugar cane experiments. With the appointment of the Assistant Agricultural Officer two years ago it was possible to increase the volume of experimental work very considerably.

Antigua.—As in the case of St. Kitts excellent progress has been made in the taking off of the large crop expected this year. Certain improvements and additions to the Gunthorpes Factory have made it possible to speed up the milling and it is anticipated that the crop, in spite of its size, will not be unduly prolonged.

St. Lucia.—Increased sugar crops are reported from the four factories in St. Lucia and the reaping is progressing normally. One of these factories is to be largely reconstructed in the near future. A great deal of interest has been aroused by a visit made to the Island by Mr. H. E. Box who has during the last two years been working on the control of the sugar cane moth borer in Antigua. Mr. Box during his visit confirmed the work of the officers of the Agricultural Department in estimating the damage done by this pest in St. Lucia and has suggested that the Cuba fly (*Lixophaga*) could with advantage be introduced into the Island. Mr. Box also confirmed the opinion expressed in these notes in April that the new parasite which Dr. Myers has found in South America may prove of value to St. Lucia.

* * *

The Sea Island Cotton Industry.

A Report has been issued by this Department on the position of the Cotton Industry since the holding of the Conference in Barbados in March, 1932. The steps taken to carry out the recommendations of the Conference have been recorded and definite proposals for the formation of the West Indian Cotton Growers' Association put forward.

The main object of the Conference was to consider the present position of the industry in all its aspects and to endeavour to find some means of bringing about a much needed improvement. The first need appeared to be to reduce production to enable the large surplus stocks to be cleared. This has been successfully accomplished as is shown from the following figures taken from the report:—

Island.	10 years Mean acreage.	Acres planted 1931-32.	Acres planted 1932-33.
Barbados ..	2,171	1,455	230
St. Vincent ..	3,668	1,754	680
Nevis ..	1,938	250	100
Anguilla ..	280	218	200
Antigua ..	599	500	200
Montserrat ..	2,960	1,500	2,000
St. Kitts ..	1,494	200	150
Total ..	13,110	5,877	3,560

Another object in view was the study of the possibility of increasing the consumption of goods made from Sea Island cotton. Subsequent to the holding of the Conference information came to hand that there were two or more firms in Great Britain which were producing articles made entirely from Sea Island Cotton. The Report records the fact that at the request of the Colonial Office the Empire Marketing Board had convened a meeting of those interested in the industry in Great Britain and that they had had under consideration the Report of the Conference.

One of the most important findings of the Conference was the recommendation that there should be formed in the West Indies an Association of Cotton Growers, a body that would be continually reviewing the position of the industry. The original suggestion was that this body should be organized as a limited liability company. A step precedent to the formation of this Association was the formation in each cotton growing island of a local association where such a body did not already exist. These local associations took longer to form than was anticipated and the last of them was created in March of this year. Since all the local associations have now been successfully organised it will now be possible to proceed with the organization of the central body and it is hoped that the first meeting of the West Indian Cotton Growers' Association will be held early in September.

The Fruit and Vegetable Industry.

The past orange and grapefruit season was dealt with fairly fully in the last quarterly notes, but owing to the outstanding account sales the season's average returns could not be given. The Dominica crop finally totalled 3,373 crates of oranges (2,742 in 1931-32) and 3,535 crates of grapefruit (2,015 in 1931-32), and the average returns from the different principal markets over the whole season are given below :—

Market.	Grapefruit.			Oranges.		
	Total Shipments crates.	Average Gross *	Average Net.*	Total Shipments crates	Average Gross *	Average Net.*
		s. d.	s. d.		s. d.	s. d.
Bermuda	175	16 4	6 9	778	18 3	8 4
St. John	967	11 9	5 7	1,948	12 2	6 11
Halifax	1,278	9 4	3 3	551	11 4	5 7
London	1,040	15 0	4 6	10	Gifts.	

For the sales made by the Government Marketing Depot the following are the average returns for the season :—

	Crates sold.	Average gross per crate.	Average net per crate. †
		s. d.	s. d.
Oranges ..	2,939	13 3	7 0
Grapefruit ..	1,734	11 2	4 9

Examination of the monthly average returns indicate that the prices were fairly well maintained through the season apart from a general drop with shipments made in December. The low Halifax grapefruit average is largely accounted for by a debit note received for a December shipment which arrived on a flooded market.

Grapefruit exports should show a further increase in 1933-34 and larger shipments will probably be made to England after filling the Canadian Maritimes and Bermuda requirements. Orange exports are not expected to show much change.

Green lime exports to New York have so far been smaller than in 1932, viz. :—

	January to April inclusive.		
	1931 Barrels.	1932 Barrels.	1933 Barrels.
Dominica ..	1,396	1,443	1,058
St. Lucia ..	414	359	150

*From Government Marketing Depot sales, except with the London figure, which is partly based on average local *f.o.b.* sales to make it more accurate.

† Return to grower per packed crate for the fruit delivered to the packing shed, *i.e.*, after deducting all packing, shipping, and selling charges.

This decrease has been due more to a shortage of fruit than to a shortage of orders, but is, however, hardly indicative of the 1933 crop which promises to be well up to the 1932 figure. Possibly, partly because of prohibition repeal in America, the green lime prices have recently dropped considerably, St. Lucia exporters only being offered, about the end of May, $4.50 to $5.00 (U.S.A. currency) per barrel *f.o.b.* This price is low for so early in the season before the main crop, especially with the smaller premium now being obtained on American currency. Small shipments to Montreal were started from Dominica and Montserrat during May. It is hoped to ship regularly until the autumn and increase the trade opened up last year in the Montreal and Toronto areas.

Shipments of mangoes (mostly Mango Longue) have been proceeding in fair quantities, shipments being made almost entirely to Bermuda. A few small lots of fruit of grafted and selected varieties (Julie and Pere Louis) have been shipped to St. John and Montreal. Mango shipments to Bermuda this season, to the end of May, have totalled :—St. Lucia, 1,424 crates; Dominica, 132 crates (about). The work carried out by the Departments in topworking seedling trees to the Julie variety and distribution of grafted plants during the past few years is now becoming evident in St. Lucia with the noticeable increase in the number of Julie fruits available. Trees topworked just over 2 years ago are now fruiting.

Small banana shipments are continuing from Dominica to England and arrangements have been made to make a trial shipment from St. Lucia in June. During the past few months some six shipments totalling about 830 bunches have been sent forward to Canada from St. Lucia. Panama disease restricts the possibilities of establishing any large trade, but under present conditions of shipping facilities and markets there seems to be no reason why a small and steady business in bananas should not be built up.

The tomato season is now virtually finished. Shipments to the end of April totalled 13,806 crates (Montserrat, 11,002; St. Vincent, 1,452; Nevis, 1,352). Later season prices were $1.50 for "Choice" and $1.20 for "Gems", but it is doubtful whether these prices will offset the lower ones obtained with larger mid-season shipments. A fertiliser trial carried out in the Botanic Station in Montserrat only shewed significant increased yields with nitrogen application. The increase in size of fruit obtained was another important feature. Pressure test experiments on the softening during ripening of fruit grown with different fertiliser treatments gave no significantly different results. Canadian agents report that the Marglobe variety ripens more evenly and firmly than the Bonny Best; one agent also observes that bruising is a big factor in subsequent softening.

Montserrat had shipped in middle May some 1,100 bushels of carrots, mostly to Canada, and shipments are still proceeding. Sales of the first 430 crates netted the grower around 60 cents per bushel, a satisfactory return with yields of around 200 bushels per acre, but later returns are likely to be lower owing to heavy Bermuda shipments.

Up to the end of April, Montserrat shipped to the West Indies 763 bushels of onions, so that despite somewhat unfavourable conditions the crop should equal that in 1932 (1931 crop, 434; 1932 crop, 828).

Trials carried out in St. Vincent have confirmed the opinion that the losses with string bean shipments in 1932 were due to the slight sweating of the beans during transport from the cold storages on shore to the ships resulting in subsequent fungal rotting. The slight temperature rise in transit and consequent sweating has no noticeable injurious effect with citrus fruits, tomatoes, &c.

A detailed analysis of the relative advantages of the St. Lucia 1930 Conference avocado pear crate and tomato crate, for packing pears, has been carried out by comparing the prices received through last season for pears shipped in these types of crate from St. Lucia and Dominica respectively, to the same Bermuda agent. The result was in favour of the latter type, when all factors (crate costs, fruit costs, freight, returns, &c.) were considered.

A fixed rate per case of 5*s*. 4*d*. subject to the usual 10 per cent. rebate, has now been secured for shipments of citrus fruit to England, as compared with the old payments based on cubic space. One of the Steamship Lines has recently specified certain minimum requirements for the opening of cold storage chambers, about 350 cu. ft., or more, depending on chamber capacity, and this decision is hampering small shipments, particularly of mangoes, the market for which fruit is in its infancy and needs development in view of increasing production. Representations have been made regarding the situation and general policy to the Line's Head Office with a view to reconsideration of this decision.

* * *

Oil of Ben.

A sample of Ben seed oil grown in the West Indies was forwarded to the Imperial Institute in 1930 and the following report was received by the Institute from a firm interested.

"The sample of Ben seeds received from you was extracted with light petroleum spirit and the oil thereby obtained neutralised, refined and subsequently deodorised.

On the 18th of January the refined sample was tested by our edible experts and they reported as follows:—

"The flavour of this oil is quite sweet and bland, and there could be no objection to its use in any edible commodity, for which its texture is suitable. There is a very marked separation of high melting constituents which could be filtered out easily, if necessary, in order to produce a salad oil."

"The sample has been further examined to-day (31st March) *i.e.*, after having been kept in the dark for 10 weeks, and the report is that the oil is still of remarkably good quality and exhibits only a very slight falling off from the high quality which it possessed when first deodorised."

The Advisory Committee of Oils and Oilseeds after considering this report and another by Mr. Sampson of the Royal Botanic Gardens, Kew, agreed that it was doubtful whether Ben oil could compete successfully with other edible oils at present available and endorsed Mr. Sampson's view that the cultivation of the seed could not be recommended.

A communication has now been received from the Director of the Imperial Institute in which he states that there had been an enquiry from Germany for the names of firms in the United Kingdom or British Possessions who manufacture the oil. Should Ben oil seed be available in any of the islands this enquiry may be of interest.

* * *

Crop diseases in St. Vincent.

The following diseases of crops were observed by Mr. A. K. Briant during his visit in St. Vincent.

Stem Rot of Coconuts.

This disease was quite prevalent in a field bordering a stream on Lauder's Estate. The affected trees were rendered fairly conspicuous by an exudation of liquid from cracks in the bark, the liquid running down the side of the trees and drying to form a reddish brown stain. Several diseased trees were observed to be in a dead or dying condition.

Mite Injury of Tomatoes.

On Arnas Vale Estate a field of tomatoes about five acres in extent was found to be badly infested with mites. The plant symptoms consisted of an abundant production of epidermal hairs on the leaves, stems, and fruits, especially on the newly formed tissues.

Superficially the plants gave the impression of having been dusted with a fine white powder, and the fruits were somewhat velvety in appearance. A portion of the field which had recently been planted was so badly affected that some of the plants had already been killed. Mr. Briant was of the opinion that the symptoms

were caused by mite injury, and informed the Manager of the estate to that effect. The examination of material brought in formalin to Trinidad confirmed his suspicions.

FUSARIUM WILT OF TOMATOES.

Wilt disease of tomatoes caused by *Fusarium lycopersici* was also present on Arnos Vale Estate.

* * *

Miscellaneous.

Mr. E. Taylor, Manager of the Government Marketing Depot, Dominica, has been granted two months leave to commence from 8th July.

Dr. Harland, Cotton Adviser to the Commissioner of Agriculture proceeded on vacation leave on 24th May and is expected to be away for several months.

Mr. J. B. Hutchinson, Assistant Geneticist, Cotton Research Station, paid early in April a visit of inspection to the Cotton Research Station in St. Vincent.

Mr. A. C. Shill, Marketing Officer, whose headquarters are now in St. Lucia made a tour through the Islands in February and March and again in June.

Mr. A. K. Briant, Lecturer in Mycology at the Imperial College has been appointed Assistant to the Commissioner of Agriculture and is expected to assume his new duties on his return from leave.

Mr. F. H. S. Warneford, Agricultural Superintendent, Antigua, went on four months vacation leave on 26th May. Mr. V. G. Pereira will act as Agricultural Superintendent during Mr. Warneford's absence.

Dr. A. E. S. McIntosh, Geneticist to the Barbados Department of Agriculture paid his promised visit to Antigua in May to study the needs of the Island in connection with sugar-cane varieties.

The Assistant Commissioner of Agriculture made a prolonged tour of St. Lucia and the Leeward Islands leaving Trinidad on 8th March and returning on 16th May. On this occasion the islands of Tortola and Anguilla were included in the tour.

Mr. A. K. Briant of the Mycological Department of the College spent eight days in St. Vincent (23rd February to 4th March), investigating the incidence of certain arrowroot maladies. Mr. Briant's report appears in another part of this issue of the Journal.

Professor H. A. Ballou, Commissioner of Agriculture goes on four months leave from the end of June prior to retirement. Mr. G. A. Jones, Assistant Commissioner of Agriculture, will act as Commissioner of Agriculture during Professor Ballou's absence on leave and on the latter's retirement will succeed him as Commissioner of Agriculture.

Mr. C. K. Robinson, Research Officer to the St. Vincent Co-operative Arrowroot Association, St. Vincent, was given three weeks vacation leave during June. During his vacation Mr. Robinson visited the Imperial College of Tropical Agriculture and consulted with certain members of the staff.

Mr. S. A. Schouten has been appointed Agricultural Assistant in Dominica during the period of Mr. Kitching's secondment to British Honduras. Mr. Schouten took his Diploma at the Imperial College in 1932. Arriving in Dominica on 5th April, 1933, he is at present Manager of the Copt Hall Fruit Farm.

Professor F. Hardy at the request of the Commissioner of Agriculture paid a visit to St. Vincent leaving Trinidad on 30th March and returning on 15th April. Professor Hardy is making a study of the soils of St. Vincent and assisted by Mr. Robinson collected a large number of representative soil samples, paying special attention to the arrowroot areas.

SMUDGING OF MANGOES.

In the *Philippine Journal of Agriculture* (Vol. III, 1932) smudging experiments to force premature flowering and fruiting in the mango are recorded. Smudging can be defined as the production of a suffocating smoke by means of a slow burning bonfire. The smudges were built at an average distance of 8 metres to windward of each tree, three smudges to every four trees, 95 trees being treated. Flower buds emerged in 84 per cent. of the cases in from seven to nine days, pollination taking place while the flowers were fragrant, two weeks after first emergence of the bud. The fruits matured in less than five months from emergence of the bud. Trees not producing flowers within 14 days of continuous smudging will not as a rule do so at all that season, particularly if the twigs and leaves are less than a year old. Smudging was discontinued when the flower buds had emerged and had grown to 5 cm. Since trees as far as 60 m. away were forced into bloom by smudging, and since in certain districts where the wind is unsuitable smudges are built on platforms actually in the branches of tall mango trees, it is considered that the premature flowering is not induced by the increased heat of the ground. The best yields were obtained from trees smudged in December and January. November smudging was not successful owing, it is thought, to the prevalence of pests and disease.

THE subscription to *Tropical Agriculture* is six shillings per annum, post free, Trinidad currency, to all countries within the British Empire or seven shillings and sixpence, post free, Trinidad currency, to all other countries. Subscriptions can commence at any time during the year.

CROP PRODUCTS MANUFACTURE IN 1932.

(Abstracted from "The Industrial Chemist," January, 1933.)

Rubber.

By S. A. Brazier, M.Sc., F.I.C.

Conditions in the rubber industry during 1932 have continued under the influence of world-wide economic and political uncertainty, although the consumption of rubber in Great Britain is estimated to be 6,000 tons more than that of 1931. The plantations still remain depressed, and the market price of standard first-grade rubber reached a new low record of $1\frac{1}{16}$d. per lb. during June. It is significant that although a large number of plantations have ceased tapping, the total production from estates in Malaya shows a definite increase, but this is counterbalanced by the fact that exchange difficulties have caused a reduction in exports from South American countries and the Dutch East Indies. The development of rubber manufacture in Soviet Russia under the Five-Year Plan is now demanding larger supplies of raw rubber, mainly for use in footwear. This is being met by purchase in the ordinary market, but also by the establishment of plantations of "Tau Sagyiz" and Guayule shrubs. Although no bulk supplies will be obtainable till 1934, big developments are forecasted during the subsequent years, and a figure of 30,000 tons is mentioned as the amount which will be obtainable in 1937.

General interest has also been aroused in the preparation of raw rubber in a "powdered" or "crumb" form. In a Dutch process, latex mixed with dextrin solution is deposited as a powder by spraying into a heated chamber. The manufacture of latex cellular upholstery is improving, and rubber thread of extreme fineness can now be made from latex and woven into fabrics such as "Lastex" elastic yarn. Several other industrial applications are being tested, such as the use of latex in moulded brake linings and the development of substances resembling leather. Another rubber product, probably obtained by the action of chlorine under suitable conditions, is being sold in Germany under the trade name of "Tornesit" for use as a protective coating for metal surfaces, either direct or as a base for pigments, lacquers, and metal varnishes.

The chemical complexity of rubber manufacture calls for much technical research, and progress is continually being made in the various processes, particularly vulcanisation. Fundamental research on the nature of rubber is also active, mainly, with a view to the production of synthetic rubber. Reports on developments in Soviet Russia indicate that experience in the operation of various plants erected has been variable, and that very serious technical difficulties have been encountered. Despite this, optimistic forecasts of a large output continue to be made, one giving an ultimate production of 40,000 tons. In America the E. I. du Pont de Nemours Company has begun production, but it is doubtful how far this has been economically successful. As the cost of production will be considerably higher than the present price of crude rubber, the synthetic material can only be used for purposes where it has specific advantages, notably where resistance to swelling by solvents is desired. It is also reported as being more resistant than the natural product to attack by ozone, oxygen, and many standard chemical reagents.

* * *

Oils, Fats and Soaps.

By Rex Furness, M.Sc., F.I.C.

The production of margarine and soap in Great Britain is dependent upon supplies of suitable oils and fats which are not home produced. It is, however, satisfactory to know that the Empire is able to supply a considerable proportion of the raw materials required by these industries. The Empire now produces 65 per cent. of the palm oil, 60 per cent. of the copra, 59 per cent. of the sesame seed, 58 per cent. of the palm kernels, and nearly one half of the groundnuts consumed throughout the world. Omitting large quantities of soya beans grown and used in China, and of cotton seed in the United States, the Dominions and Colonies provide more than one half of the world's oilseeds and nuts.

The Empire is thus particularly well supplied with the oils used in the manufacture of margarine and soap. In addition, the United Kingdom, which is among the chief seed-crushing countries, imports cotton seed, linseed, and soya beans, supplies of which within the Empire are not very considerable. Moreover, the bulk of the groundnuts from India and Nigeria, of the copra from British Malaya and Ceylon, and even the West African palm kernels and palm oil, go to Germany, France and other countries.

The manufacture of margarine has become a very important industry in Britain, some five million cwts. being produced per annum. It is now accepted as a high-grade foodstuff, and special products of the largest manufacturing organisation have been available for some years with a vitamin content equal to that of the best summer butter. The relative absence of vitamins A and D from ordinary margarine is perhaps the most serious criticism that can be levelled against its use to replace butter. Not only has this difficulty been overcome, but an advance of some importance appears to have been made in the development of a butter-like aroma in margarine. It is based on the discovery that the characteristic aroma of freshly made butter is due, in the main, to the presence of an extremely small proportion of diacetyl.

CULTIVATION AND DISEASES OF THE BANANA IN BRAZIL.

FIG. 5.—*Extension of banana cultivation from the plain to the hillside. The illustration also shows the stature of the primary bush in those regions.*

FIG. 6.—*An early stage in the development of a banana plantation. The underbush is cut down and the "bits" planted prior to the felling of the larger trees.*

CULTIVATION AND DISEASES OF THE BANANA IN BRAZIL.

FIG. 7.—*This illustration shows the poor stature of plants on derelict land after 15 years continuous cropping.*

FIG. 8.—*Shows the fine stand of plants obtained as the result of deep implemental tillage. The areas shown in Figs. 8 and 9 lay on either side of a railway track in close proximity.*

FIG. 9.—*Type of pulley system installed to facilitate*

CULTIVATION AND DISEASES OF THE BANANA IN BRAZIL.

FIG. 10.—*Reaping operations : to minimise bruising, each bunch is placed in a stout paper bag which is slipped over the fruit prior to reaping.*

FIG. 11.—*Bagged fruit being collected at a railway siding.*

FIG. 12.—*Bagged fruit being stowed in a barge.*

FIG. 13.—*Typical banana barges filled with fruit waiting to be towed down the river.*

Bulletin of the Imperial Institute

A Quarterly Record of Progress in Tropical Agriculture and Industries and the Commercial Utilisation of the Natural Resources of the Dominions, the Colonies and India.

Prepared by the Scientific and Technical Staff of the Imperial Institute assisted by other Contributors.

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Royal Society for the Encouragement of Arts, Manufactures and Commerce.

THE ROYAL SOCIETY OF ARTS was founded in 1754, and incorporated by Royal Charter in 1847, for the encouragement of the Arts, Manufactures and Commerce of the country.

At present the Society numbers about 4,000 Fellows. The annual subscription is Three Guineas, the life subscription Thirty Guineas. There is no entrance fee.

Fellows are entitled to be present at all Meetings of the Society. These include the Ordinary Meetings, held every Wednesday during the Session, when papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed; the Meetings of the Indian and Colonial Sections, at which subjects connected with our Indian Empire and the Colonies and dependencies are considered, and the various lectures on technical subjects delivered under the Cantor and other trusts. Fellows also receive a weekly copy of the *Journal* which contains full reports of the Society's proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce; and they are entitled to the use of the library and reading room

Proposal forms and further particulars relating to the work of the Society, may be obtained from the Secretary, Mr. G. K. Menzies, at the Society's House, John Street, Adelphi, London, W.C. (1).

The British soap industry is being maintained at a high level of efficiency, both on the technical and commercial sides. The constant attention which is paid to the development of new products in attractive forms, and to the extension of older and established lines, makes an appeal to the home public, whilst exports must be regarded as reasonably satisfactory in view of the general world situation. The replacement of a large proportion of formerly imported toilet soaps by high quality British soaps cannot be ascribed entirely to changes in the financial situation.

D. W. D.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Supersaturation in Graining. *By J. G. Thieme.*

In the boiling process it is of importance, both from the theoretical and practical points of view, to know at which supersaturation a syrup begins to show crystal formation, since this degree will represent a limit below which in the further course of boiling one must endeavour to remain, if false grain is to be avoided. It is further of value to ascertain whether this critical supersaturation is more or less constant for different syrups and for different conditions. Varying opinions are expressed in recent literature on these points, and indeed for the cane sugar industry they have yet to be decided. According to some opinions, grain appears entirely "voluntarily"; but according to others either mechanical influences, or else the presence of "seed" is necessary.

What interests one especially is the supersaturation at which one can observe the first appearance of crystals. It appears from the well-known investigations of Van Ginneken(1) that using pure sugar solutions under laboratory conditions crystals were formed sooner or later at every supersaturation employed, the time necessary being dependent on that supersaturation. The lowest concentration used was 79.97° at a temperature of 80°C., corresponding to a supersaturation of 1.10, from which it is probable that spontaneous crystallization might occur at even lower supersaturations, though only after a very long time. On the other hand, Kucharenko (2) has pointed out that under certain conditions even at very high supersaturations no spontaneous crystallization takes place, which conditions (according to him) consist in the entire absence of "seed". According, however to Sandera (3), this phenomenon may be explained by too great a viscosity at the very high supersaturations employed.

But in the case of impure solutions the determination of the degree of supersaturation is much more difficult. On the basis of tests continuously made during many years, Claassen has come to the conclusion that the formation of grain takes place from 1.2 to 1.5. In the cane sugar industry, this opinion is also to be found. In fact, prevailing belief in the sugar industry as a whole can be formulated thus: *Primary grain originates only at very high supersaturation always above 1.2 so that during the further course of boiling one avoids the re-appearance of crystals by holding the supersaturation below 1.2.*

It soon becomes evident, however, that primary grain may sometimes appear at a much lower supersaturation than may be expected from this formula, though exact figures are lacking. Thus in Stanek's experiments at Djatiroto s.f., Java (4), the primary grain was visible (test 4) at a temperature of 61°C., and a refractometric Brix of 78.8°. In a sample taken at this moment the sucrose content was 64.8, so that the sucrose per cent. water was 305.7. Grain was already visible at a supersaturation of 1.10. This same author applying Thieme's saturation tables at 61°C. to no fewer than 70 actual determinations found some supersaturations at which the primary grain appeared of only 1.07.

Are we now to assume that for cane syrups such very lower supersaturations at primary grain formation are normal; in other words, is the supersaturation at which primary grain appears a constant within certain limits; or does it differ considerably according to the nature of the syrup, and according to conditions, such as purity? Honig and Alewigjn (5) regard the former possibility as plausible; while Stanek (6) considers the latter to be probable. It is undoubtedly only a matter of time until further data shall have been determined at different factories, permitting one to decide between these two opinions.

Anyone who has had experience in pan boiling must have observed that the tendency to form primary grain differs much at different factories. Thus, learning to boil at one factory, and later demonstrating this knowledge at another, has often proved an unpleasant experience. Cloudy syrups have a great inclination to grain formation. which even in the presence of already-formed grain, and after lowering the supersaturation by drawing in, can be very disturbing. That

1. *Archief*, 1919, II, p. 2198.
2. *Archief*, 1924, I, p. 83; through a trans. repro. in the *Louisiana Planter*.
3. *Zeitsch. Zuckerind Czechoslov.*, 1927, p. 401.
4. "Het Kookproces in de Java-suikerfabrieken" Soerabaja. 1932.
5. *Archief*, Mededeelingen, 1932, No. 16.
6. *Ibid.*

this is due to some property of the juice, and not to certain faults in boiling, is seen from the fact that, when the fine crystals in such a syrup have been completely re-dissolved for a new strike, the same phenomenon is exhibited on re-boiling.

Van Der Linden (7) has experienced this inclination to false grain formation on the part of some syrups, and also molasses, in his investigations on exhaustion. There are, however, several indications that premature spontaneous grain formation at low supersaturations is not a rule, but is due to certain causes. First may be mentioned the presence in the pan of crystals of a previous strike, in which connection Huese (8) has insisted on a good steaming-out of the pan. Stanek (9) states the very interesting opinion of his Chinese foreman pan-boiler, viz.; that due to the splashing up of the syrup against upper serpentines which had become heated by leaky steam, crystals had been formed and had fallen down into the boiling syrup below. Douwes Dekker (10) points out that very fine sugar dust is being continuously drawn with the air into the pan through leaks ; and another cause is the provoking effect of cloudiness, which has already been mentioned. It is very easily conceivable that for such low supersaturations as Stanek has observed at Djatiroto several of these factors may work together.

According to the present author, our knowledge to-day of the rôle of supersaturation in graining and boiling in cane sugar factories may be expressed as follows: during the gradual thickening of the syrup in the pan, primary grain forms at a supersaturation which cannot be stated beforehand. Generally this supersaturation varies for the same factory and for the same type of syrup only within small limits; but in some factories it can vary considerably, and can fall to a very low value. One must always endeavour to raise the supersaturation so far that the utmost number of crystals are formed in the shortest time. In order to cause the crystals to grow, and to form as few fresh ones as possible, one must in the further course of boiling hold the supersaturation so low as is possible, though at extremely low supersaturations (from 1.1 to 1.2) one can never be certain that no new seed crystals will be formed.—(*Inter. Sugar Jour.*, Vol. XXXV, No. 412.)

7. *Archief*, 1919, II, p. 1517.
8. Handelingen 10e. congres (1928), II, Verslagen, p. 995.
9. *Ibid.*, p. 37.
10. *Archief*, 1931, II, p. 1079.

THE EDITOR requests that any subscriber who fails to receive *Tropical Agriculture* regularly should communicate with him immediately in order that the matter may be rectified.

SOIL RESEARCH AT THE CEYLON TEA RESEARCH INSTITUTE.

Monthly letter No. 15 of the Imperial Bureau of Soil Science gives a description by Mr. T. Eden of the soil work of the Ceylon Tea Research Institute.

Fundamental research is being carried out on the generic characters of tea soils, and it has been found that marked soil differences occur from place to place and elevation to elevation in colour, texture, and physical properties. In particular the silica-alumina ratio of the clay fraction has been measured for a range of soils in order to study the degree of lateritisation. It is hoped that by obtaining a more complete picture of the composition and behaviour of the clay fraction it will be possible to throw light on the position of these soils in the weathering range between lateritisation and podsolisation.

Soil erosion is also being studied with a view to finding the effects of land-opening, cultivation, and drainage, on surface run-off. An experimental area has been laid out in randomised plots, in which measurements of water level at frequent intervals during heavy rain give records of run-off, while drainage samples taken at the same time provide data on erosive action. In conjunction with the field measurements, bi-monthly samples are drawn to follow the loss of organic matter, particularly the depreciation of carbon and nitrogen.

Green manuring forms an important part of husbandry in Ceylon, both on account of its effect on the nutritional cycle and on the prevention of soil erosion. Great difficulty is experienced from time to time in establishing leguminous cover crops and it has been observed that leguminous nodules are generally scarce. With the co-operation of the Bacteriological Department of the Rothamsted Station, the Mycological Department of the Institute is classifying the most generally used green manures according to the nature of their nodule symbiote.

The effect of soil reaction on the tea plant is so marked that this has been set apart as a special line of research. While healthy growth is possible over a very wide range on the acid side, unhealthy symptoms appear with increasing alkalinity, and the various stages in this sequence are being investigated.

Preliminary work on the technique of field experiments on tea has afforded guidance in the matter of plot size, shape, and replication, and on routine handling of the experimental areas. Manurial trials have been set up with potash, organic nitrogen, and inorganic nitrogen, but the experiments have not been running long enough to permit discussion of results.

IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

COLLEGE NEWS BULLETIN

JULY, 1933.] [No. 3.

COLLEGE NEWS.

Mr. G. Evans, Principal, and Mrs. Evans sailed for England by s.s. *Camito* on 30th May.

* * *

Dr. H. R. Briton-Jones, Professor of Mycology and Bacteriology will act as Principal during Mr. Evans' absence on leave.

* * *

Mr. D. W. Duthie has been elected Hon. Secretary to the College Amalgamated Clubs in succession to Mr. A. K. Briant.

* * *

Mr. F. Hardy, Professor of Chemistry and Soil Science, recently visited St. Vincent for the purpose of carrying out a soil survey.

* * *

Mr. A. K. Briant, formerly College Lecturer in Mycology and Bacteriology, has been appointed Assistant to the Commissioner as Advisory Pathologist, and will take up his new work when he returns from leave.

* * *

Mr. N. E. Sanderson, Deputy Manager of the United Fruit Company, Jamaica, paid several visits to the College to discuss with the scientific officers concerned various aspects of recent developments in research.

* * *

Mr. G. A. Jones, who has been appointed Commissioner of Agriculture in succession to Professor H. A. Ballou, assumes charge of his new duties on 1st July when Professor Ballou proceeds on leave prior to his retirement.

* * *

At the request of the Director of Agriculture, Mr. W. A. Paterson, who is attached to the Barbados Department of Science and Agriculture visited Trinidad and stayed for about ten days. During his visit he made himself familiar with the Diploma Course curriculum and the College research activities.

* * *

His Excellency, the Governor of Trinidad and Tobago paid an official visit to the College on 22nd May. Sir Claud Hollis, who was conducted round by the Principal, spent several hours inspecting the various departments. He was particularly interested in the recent developments of the banana and cacao research investigations.

Mr. R. E. D. Baker, B.A. (Cantab.), one of this session's Colonial Office Scholars, has been appointed Junior Lecturer in Mycology and Bacteriology on probation for one year, in the vacancy caused by the promotion of Mr. Briant. He assumed his new duties on 23rd June. Mr. Baker was educated at Oundle School, and Trinity Hall, Cambridge.

* * *

Mr. Alan Pickles, Entomologist to the Sugar Cane Investigation Committee, Trinidad, sailed by s.s. *Orange Nassau* on 27th May for British Guiana. He joined there Dr. J. G. Myers and is now on his way to the interior of Brazil where a search will be made for Froghopper parasites. Mr. Pickles is expected to be away for almost five months.

* * *

It is with very great regret that we have learnt of the death, from pneumonia, on 11th March at Triscombe, Dorking, of Lawford Hugh Anderton Stone. Stone, who was 29 years of age, came to Trinidad as an Empire Cotton Growing Corporation Scholar in 1926. Affectionately known as "Tiny" he was one of the most popular students of his year.

* * *

Recent departures for England include: Mr. C. Y. Shephard, Professor of Economics, and Mrs. Shephard by s.s. *Coronado* on 2nd May; Mr. R. C. Wood, Professor of Agriculture, and Miss Wood, Mr. A. K. Briant and Mrs. Briant and Mr. F. J. Pound, Geneticist to the Cacao Research Scheme, by s.s. *Bayano* on 16th May. Mr. F. Hardy, Professor of Chemistry and Soil Science, sailed for England by s.s. *Bayano* on 27th June, and Dr. J. R. Dickson, Medical Officer of Health, and Mrs. Dickson on 13th June by s.s. *Costa Rica*.

* * *

Recent visitors to the College have included the following:—Brigadier J. C. W. Langhorne, Inspector-General of H. M. Forces in the West Indies, and Mrs. Langhorne, Lady Moore Guggisberg, Mr. Douglas, Mr. Ramsay, Mr. James R. Weir of the Ford Motor Works, Detroit (who was returning from a visit to Brazil), Mr. and Mrs. Andrew Miller of Toronto, Mr. E. M. Murphy of Swastika, Canada,

Dr. F. A. Bather of the British Museum, Mr. J. S. Rucker of the Demerara Bauxite Co., Mr. F. C. Trott, a Director of Lloyd's Bank, London, Messrs. Louis W. Paish and W. F. Maides, of Croydon, England, Mr. and Mrs. R. Beaumont, Trinidad Leaseholds, London, Dr. D. F. Koerner, Ministry of Agriculture, Poland, Lady Cadman, Mr. C. Douglas-Jones, Colonial Secretary, British Guiana, Major G. Gonsalves, Lt.-Colonel G. L. C. Hinds-Howell, Mr. S. Bradshaw, Manager of the United Fruit Co. at Santa Marta, Professor J. S. Dash, Department of Agriculture, British Guiana, and Mrs. Dash, Mr. G. W. Peterkin, Department of Agriculture, British Guiana, Dr. H. E. Sutherland Richards, D.M.O., Grenada, and Mr. P. A. Bovell of Jamaica.

* * *

As the result of a proposal emanating from the Gold Coast, the Governing Body at the request of the Secretary of State has agreed that Mr. C. Y. Shephard, Professor of Economics, should proceed to the Gold Coast in October on the conclusion of his present leave in England. He will remain in that Territory until the end of March and then, at the special request of the Nigerian Government, will tour for six weeks in that Colony before returning to Trinidad. The main object of Professor Shephard's visit is to examine the state of the co-operative credit societies in the Gold Coast, and to make recommendations with regard to the future development and organizations of the co-operative system generally. He will also have the opportunity of making a detailed study of the economic conditions of the cacao industry in the Gold Coast, and in Nigeria, and will no doubt have interesting comparisons to announce between the peasant system of cacao production in the Gold Coast and the plantation methods that are prevalent in the West Indies. He will incidentally have the pleasure of renewing many old acquaintances since the Agricultural Departments of both Colonies contain in their ranks many ex-students of the College.

The Gold Coast Government have consented to an exchange of officers, and we shall welcome Mr. A. W. Paterson, an officer of the Gold Coast Agricultural Department next session. He has been seconded for special duty at the College during Professor Shephard's absence and will be in charge of the office of Professor of Economics.

THE EASTER TOUR TO BRITISH GUIANA.

It has become an established practice to include a visit to some of the neighbouring Colonies during the Easter vacation, as part of the course of training for post-graduates. A visit of this sort enables students to learn something of the organization and working of another agricultural department, and gives them an opportunity to see some of the administrative difficulties that confront the agricultural officer during the normal course of his duties. The local problems that arise in agriculture and the methods that are being employed to overcome them are always of absorbing interest to the student.

In the last few years, the Easter trip has generally consisted of a visit to Barbados and St. Lucia, but this year it was decided to visit British Guiana. The decision has not been regretted since this Colony possesses a well organized Department and is staffed with highly qualified officers. Under the stimulus of a progressive and enlightened Director it is making excellent progress towards solving some of the problems of that — agriculturally at least — difficult country.

The tour lasted eleven days as the party left Port-of-Spain on Saturday, 25th March, and returned on 5th April. The time actually available in British Guiana was somewhat limited but thanks to the excellent arrangements made by the Director, Professor J. S. Dash, and his assistants, it became possible to see a great deal of the coastal belt, although naturally a visit to the interior was not possible. Sugar is the main crop of the Colony, and is receiving a great deal of attention. At St. Sophia Sugar Experiment Station many problems are being tackled and new varieties are being bred to suit local conditions since those under which cane has to grow in Demerara are quite unlike those of other cane-producing countries. The soils are exceptionally heavy and are mostly very acid in character; the land dries out very rapidly during periods of drought, and irrigation is necessary if satisfactory cane crops are to be produced. The method of empoldering which characterises the whole of the cultivated area in British Guiana, with the complementary systems of drains and irrigation channels were noted with interest. In the last three or four years the yields of sugar and cane per acre have

increased very noticeably. This is largely due to the newly introduced system of "flood fallowing", whereby a cane field, after it has been thrown out of cultivation, is kept flooded to a depth of three or more feet for periods varying from 6 to 18 months. The land is then drained and, contrary to all previously accepted dogmas, is found to be in very good tilth and far more easy to work than before flooding. The resultant yields of cane are invariably excellent. The scientific explanation of this phenomena is being sought by the officers of the Department. Excellent examples of flood fallowing were seen on the sugar plantations at Blairmont and Lusiguan.

The second most important crop is rice, and a good deal of time was spent in examining the departmental activities in regard to this crop. The rice breeding experiments were explained in great detail. Already good progress has been made in eliminating red grain with which the crop of the country was so badly infested up to a few years ago. The next stage, that of instituting pure lines of high yielding strains, is making remarkably rapid strides. In fact the College party were inclined to believe that pure line selection is likely to yield quicker results than the attempts that are being made to raise new seedlings by hybridization. The rice milling system was examined, and mills of various degrees of efficiency were seen on the Essequibo coast. A system of rice grading has been introduced by the Agricultural Department with great success, but presumably the time has now come to hand this on to a non-official agency.

Another aspect of the Department's activities is concerned with land settlement and peasant agriculture—on the Essequibo coast. The sugar industry has practically closed down in this district and the land has turned from sugar to paddy. The experiment in closer settlement that is being conducted at Bush Lot was visited, and the situation explained by Mr. Burnett, the Assistant Director. It is too early to state whether the system adopted at Bush Lot is likely to prove a success and to be applicable on a wider scale, but at any rate the Government are obtaining valuable and reliable figures as regards costings.

With such a full programme of work, there was naturally little time available for social functions—on the Saturday, however, His Excellency the Governor and Lady Denham gave a garden party to the College, a compliment that was greatly appreciated, and on Friday a depleted College team was defeated at rugby football by the Georgetown Club after a strenuous and evenly contested game.

In conclusion one cannot but express gratitude to the Director of Agriculture and his officers for the excellent arrangements made, and for the manner in which they responded to the numerous questions with which they were bombarded. The hospitality of British Guiana is proverbial and this occasion proved no exception. One left with a sense of grateful thanks to all of the officials, managers of plantations and others who so graciously entertained us.

G. E.

AGRICULTURAL EXCURSIONS.

A visit was paid on 22nd March to River Estate where the Trinidad Department of Agriculture has for many years been conducting experiments on cacao. Originally an abandoned sugar estate, River was purchased by the Government in 1897 and in 1908 it came under the Department of Agriculture. The area is 1,629 acres, of which 500 acres are under cacao, 500 under timber and small areas under citrus. Much of the area is rough hill land and uncultivated. Although the Estate is run on commercial lines it has been found possible to carry out a number of experiments which have proved of particular value to the cacao industry and more recently, also, to the officers of the College Cacao Research Scheme who have been able, through the courtesy of the Director of Agriculture, to make use in their researches of the experimental data collected.

Among the experimental series visited were the shade and no shade and spacing experiments and the propagation series. Of particular interest was the lay-out of an experiment to test the effect of various combinations of artificial manures. This problem has always presented some difficulties in permanent crops and an additional difficulty in this instance is the presence of the 'immortelle' shade trees. The College party was entertained to lunch by the Department, and Mr. S. M. Gilbert, who presided, described briefly the aims and objects of the station. After lunch, the estate buildings were inspected and such matters as the methods of fermenting cacao, the housing of labour, and tropical sanitation problems were discussed.

A visit to the Usine Ste. Madeleine sugar estates was made on 12th April, 1933. This company controls an acreage of about 24,000 acres, of which about 20,000 acres are under cane. The cane area cultivated by the estates is approximately 14,000 and the rest is rented out to cane farmers. The morning was spent in going round the estates and particular interest was evinced in the dry weather cultivation. Owing to the undulating character of the Naparimas, the cable system of steam ploughing is not in favour and is being replaced by cultivation by direct traction using caterpillar tractors. The ploughing of old cane lands with discs which turn the land over to a depth of 14 or 15 inches is particularly impressive. We would imagine that this has done much to keep in check insect pests such as the froghopper. The use of tractors in intercultivating young ratoons and in making cane beds, grading, ridging and digging main drains is also favourably commented on. With regard to stock, the management explained that there is a tendency to extend the use of bisons (Indian buffaloes) instead of oxen or mules. The chief advantage claimed is the hardiness of bisons, while during the off season they cost practically nothing to keep. The rations for mules in particular are on the other hand a heavy charge throughout the year. The economy in harness is also considerable.

The General Manager, Mr. G. B. Westwood, entertained the College party at his residence and the Principal in proposing a vote of thanks referred to the remarkable progress made by the Ste. Madeleine Company during the last two or three years. It was the largest sugar-producing company in the British Empire and its increased production and the fact that it had now become possible to recommend the payment of dividends, spoke volumes for the efficiency of the management. Mr. Westwood in his reply stated that the Ste. Madeleine Company had been closely connected with the College since the latter institution had come into being. Both institutions had collaborated in experimental work in the past, particularly in the extended trials of artificial fertilizers. Mr. R. S. Ball, one of the Post-Graduates, proposed a vote of thanks to the ladies of the estate who had done so much to make the function a success. Mr. Ball's speech was very happily worded. Mr. R. B. Torrance, the chief accountant of the Company, suitably replied.

In the afternoon, visits were paid to the dairy herd and to the model dairy which provides wholesome milk not only to the estate officials but also to the hospital and other institutions in the neighbourhood. Later on the party were conducted over the sugar factory by Mr. H. E. Mayes, the chief engineer.

BIRTHDAY HONOURS.

We offer our heartiest congratulations to Sir James Currie, Chairman of the Governing Body of the College, on whom the honour of K.C.M.G. has been conferred, and to Professor H. A. Ballou, Commissioner of Agriculture for the West Indies and Professor of Entomology at the Imperial College of Tropical Agriculture, who becomes C.B.E.

ASSOCIATESHIP AWARDS.

The following students have recently been awarded the Associateship of the College :—

Mr. A. R. Foster, B.Sc. (Reading).
Mr. G. R. Murray, B.Sc. (Reading).
Mr. C. H. B. Williams, Dip. (I.C.T.A.).

OLD STUDENTS' CORNER.

W. I. M. Armstrong Black (1930-31) has been appointed Assistant Agricultural Chemist, Nyasaland.

* * *

J. L. B. Hutchinson (1924-25) has resigned his post of Assistant Geneticist to the Cotton Research Station, Trinidad, to take up an appointment as Geneticist and Botanist to the Institute of Plant Industry, Indore, India.

BIRTHS.

Linton (1928-29).—On 26th February, at Belfast, to Eileen, wife of Reginald D. Linton—a daughter.

* * *

McDonald.—On 18th April, at St. Augustine, to Thelma, *née* Seheult, wife of J. A. McDonald, Chemist to the Cacao Research Scheme—a son.

* * *

Pyke.—On 20th May, at St. Augustine, to Aeta, *née* Jardine, wife of E. E. Pyke, Botanist to the Cacao Research Scheme—a son.

Printed by the Government Printer.

CHEMICAL NOTES

Compiled by the College Department of Chemistry and Soil Science.

Manurial Experiments in Barbados.

The *Barbados Agricultural Journal* for October, 1932, gives a discussion by Saint of the results of manurial trials carried out with sugar-cane between 1928 and 1932, and recommendations are put forward as a result of this work. Saint considers that the supply of water, potash, and nitrogen are the principal factors affecting the yield of sugar-cane in Barbados.

Loss of water from the soil should be minimised during the dry season by mulching the cane with trash, sour grass, or other organic matter, or by maintaining a loose covering of surface soil with the aid of harrows. Experiments have shown that in normal years mulching will result in an increased yield of about 4 tons of cane per acre. An increase of the humus reserves of the soil is also recommended for the same reason, either by manuring the sour grass pastures to obtain a greater supply of mulch, or by green manuring.

With regard to nitrogen and potash, the application of 60-80 lb. per acre of available nitrogen and 80-100 lb per acre of available potash, is considered sufficient to grow the maximum crop. The form in which these elements are applied is immaterial, and therefore the cheapest method is suggested, namely, sulphate of ammonia and muriate of potash. In short, the manuring recommended for the planter, for both plant canes and ratoons, is as follows:—

In January: 2-2½ cwts. per acre of a mixture of three parts sulphate of ammonia and five parts muriate of potash

In July when the rains commence: 2-2½ cwts. sulphate of ammonia per acre.

Pen manure is considered to be unnecessary, if the fields are treated with mulch or green manure in the manner outlined above. This allows reduction of stock to the minimum necessary for the cultivation of the plantation, and mechanical tillage can be applied wherever it is economically practicable.

* * *

Periodicity in Tree Growth in the Tropics.

An interesting contribution on this subject by Jean Schweizer, of Djember, Java, has appeared (*Mitt. Naturforsch. Ges. Bern*, 1932). As a result of the recent extensive vegetative propagation of *Hevea Brasiliensis*, it is now possible to compare the behaviour of clones, propagated from the same individual, under widely different conditions of cultivation and climate. The author has thus been convinced that individual differences as to time of leaf production, length of rest period, &c., are inherited characteristics, although they may be modified by climate, altitude, manurial treatment, &c. He points out that the rest periods of seedlings of *Hevea* are comparatively short, and two or more crops of foliage may be developed in the year, but that the rest periods increase in length with the age of the individual, when the periodicity tends to be linked with the annual climatic cycle. An interesting observation was the effect of manurial treatment in temporarily obliterating the markedly individual behaviour shown by the different branches of the same trees as to the period of leaf production; an individuality which reappears in later years as the effect of the manure diminishes. The results of defoliation experiments are described and shown to depend upon the periodicity of growth processes at the apex. When the new crop of leaves is expanding, the growing point is forming new leaves and at this stage defoliation has little effect on the periodic cycle. Later, the growing points are forming flower buds and defoliation during this period may postpone the rest period. — (*Nature*, Vol. CXXXI, 29th April, 1933, p. 624).

* * *

Rapid-filtering Kieselguhr.

Kieselguhr has been used for a number of years in operations, such as the production of white sugar, in which special filter-aids are necessary to remove microscopically small particles. Since this material, however, is very variable in quality and may contain impurities affecting its efficiency, efforts have been made during the past few years to improve it, and with very successful results. Rapid-filtering kieselguhr under the trade name of "Filter-guhr" is now sold in an extraordinary high state of purity, being practically insoluble even in acids, and free from organic matter and acid-soluble iron. When this material is deposited on a filter cloth in a thin layer, it becomes possible to remove the finest insoluble matter, and incidentally enables a cloth of cheaper quality to be used in the filter press. The great advantage claimed for "Filter-Guhr" is that it increases the rate of flow, whilst giving porous cubes and brilliant filtrates. It is prepared in three grades, No. 70-S a ground powder, No. 701-S an extra-white ground powder, and No. 80-S a white air-floated powder. It is free from acid and in fact slightly alkaline to phenolphthalein but an absolutely neutral grade can be supplied when required. The manufacturers, the Vereinigte Deutsche Kieselguhrwerke, of Hanover, Germany, are represented in England by the selling agents, S. Heim, Ltd., Tower House, 40, Trinity Square, London, E. C. 3.—(*Chem. and Ind.*, Vol. LII, No. 11, p. 248, 1933.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

COCOA.—The market has been under the influence of fluctuations in the U.S. dollar and there is a general tendency for interested parties and outsiders to gamble in commodities. Manufacturers have shown little buying interest having evidently anticipated their requirements. Prices have consequently advanced within narrow limits. —(*By courtesy of the Cocoa Planters' Association of Trinidad, Limited.*)

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association :—

	American Mid.	*Egyptian F.G.F. Sakel.*
28th Apr. ..	5·53	7·45
5th May ..	5.89	7.84
12th May ..	6.19	8.19
19th May ..	5.96	8.10
26th May ..	6.07	8.17
2nd June ..	6.37	—
9th June ..	closed	—
(*10th June*, 1932) ..	4.09	5.55

There has been a fair amount of fluctuation during May but on the whole prices have tended to advance steadily. This has been mainly due to the U.S.A. inflation campaign and President Roosevelt's declaration that an advance in commodity prices is definitely aimed at. The *West India Committee Circular* (25th May) report that a good business has been done in West Indian Sea Island chiefly at 14*d*.

* * *

SUGAR.—Prices on the Home Market have ranged as follows (*c.i.f.* per cwt.) :—

	Foreign. s. d.	*Preferential.* s. d.
27th April ..	5 6	10 3½
4th May ..	5 6	10 3
11th May ..	5 4½	10 1½
18th May ..	5 5¼	10 2¼
25th May ..	5 7½	10 4½
1st June ..	6 1½	10 10½
8th June ..	6 1½	10 10½
(*9th June*, 1932) ..	4 9	9 6

A quiet tone has generally prevailed in the market. Prices have, however, been steady and a moderate amount of business has passed both in raws and refined.

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

	d.
26th Apr.	$2\frac{19}{32}$
3rd May	$2\frac{23}{32}$
10th May	$2\frac{13}{16}$
17th May	3
24th May	$3\frac{1}{32}$
31st May	$3\frac{1}{2}$
7th June	$3\frac{17}{32}$
(*8th June*, 1932)	$1\frac{3}{4}$

The market during the past month has been firm and active with steadily rising prices. The advance is stated mainly to be due to renewed restriction talk and so-called controlled inflation in America. *Symington and Wilson* report that the *American Questionnaire* consumption figures show a distinct improvement upon last year, while the ratio of reclaimed to crude rubber at 16.8 per cent. is the lowest on record.

* * *

BANANAS.—The demand is improving consequent on the warmer weather, but prices to wholesalers are unchanged at £21 5*s*. per ton delivered London and £21 nearest railway station for Jamaicas and £19 nearest station for Brazilians. (*West India Committee Circular*, 25th May, 1933.)

* * *

COFFEE.—Prices have generally been maintained. Recent sales have included Jamaica greenish mountain at 198*s*. and No. 2 at 177*s*. per cwt. Up to 220*s*. has been paid for fine bold, 192*s*. for second size, and 110*s*. for third size. Stocks of coffee are 489,000 cwt. as against 379,000 cwt. a year ago.

* * *

COPRA.—Copra is firm with West Indian *f.m.s.* a little higher at £11 10*s*., buyers for June shipment *c.i.f.* London or Liverpool.—(*West India Committee Circular*, 25th May, 1933.)

* * *

TEA.—Latest averages according to the *Times Trade and Engineering Supplement* (27th May) include Ceylon at 11.09d., Indian 9.75*d*., and Java 7.09*d*. Stocks are very high.

* * *

LIME PRODUCTS.—*Lime Oil.*—There are sellers of Handpressed at 47*s*. 6*d*., but practically no demand. Distilled is easier with sellers willing to meet a market.

Lime Juice.—Small sales of Raw have been made at 1*s*. 10½*d*. to 2*s*. 6*d*. per gallon according to quality. Business has been done in Concentrated at £4 10*s*., but there is no indication of a sustained demand.—(*West India Committee Circular*, 25th May, 1933.)